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Engineering Library

# The Engineer.

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VOL. CXXXIII.—No. 3469] LONDON: FRIDAY EVENING, JUNE 23, 1922 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

## PUBLIC NOTICES

**Assistant Engineer Required** by the GOVERNMENT of NIGERIA for the Lagos Harbour Works, for two tours of 12 to 18 months' each, with possible extension. Salary £800, rising to £720 a year by annual increments of £30, and thence to £950 a year by annual increments of £40. An outfit allowance of £60 paid on first appointment. Free single quarters and passages. Liberal leave in England on full salary. Candidates, age between 28 and 35, must be duly qualified civil engineers and must have had a wide experience (including dress diving) on an engineer's or contractor's staff in the actual construction of harbours and dock works, both by contract and departmentally. Apply at once, by letter, giving age and brief details of experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting M/11,500. 8561

**The High Commissioner** for India is prepared to receive TENDERS for the SUPPLY of :—

1. STEEL SCREW SPIKES FOR RAILS.
2. MILD STEEL HOOP.
3. CABLE, UNDERWATER, UNARMOURED, SINGLE WIRE, BRASS TAPED, G.P.
4. CABLE, FIVE WIRE, V.I.R. INSULATED AND LEAD SHEATHED.
5. BRAIDED WIRE FOR CROSSINGS OVER POWER CIRCUITS.
6. STEEL STRIP FOR CHARGERS.

Forms of Tender may be obtained from the Director-General, India Store Department, Belvedere-road, Lambeth, S.E. 1, and Tenders are to be delivered at that office not later than Two o'clock p.m. on Friday, the 7th July, 1922, for Nos. 1 and 2, on Friday, the 14th July, 1922, for Nos. 3 to 5, and on Friday, the 21st July, 1922, for No. 6.

T. RYAN, Director-General.

8540

ASSISTANT LOCOMOTIVE SUPERINTENDENTS, INDIAN STATE RAILWAYS.

**The Secretary of State for India** will, in 1922, with the advice of a Selection Committee, make FOUR APPOINTMENTS as ASSISTANT LOCOMOTIVE SUPERINTENDENTS for service on Indian State Railways, if so many suitable candidates present themselves.

Candidates must be British subjects, not more than 26 years of age, and must be of good moral character and sound physique. They must have had a good general and technical education, followed by at least three years' training in the locomotive workshops of a British railway company or a locomotive builder of repute, and should have had six months' training in the running sheds and firing. A knowledge of applied mechanics and composition of all materials used in shops is essential, and applicants should be able to design and to calculate the stresses on the parts of the machines. Some drawing-office experience is also desirable.

Persons whose practical experience falls short of three years, but who have served in His Majesty's Forces during the war, will be eligible as candidates; but, if selected, will be required before appointment to complete satisfactorily such further period of training as the Secretary of State may prescribe.

Candidates may be required to appear before a Selection Committee at the India Office. They will also be required to pass a medical examination if selected for appointment.

The regulations in respect of the appointments and forms of application for use by candidates can be obtained on application to the SECRETARY, Public Works Department, India Office, Whitehall, London, S.W. 1. Applications for appointment must reach the India Office not later than 31st July, 1922.

India Office,
18th June, 1922. 8525

**Finsbury Technical College,**
LEONARD-STREET, CITY-ROAD, E.C. 2.
Dean for the Session 1921-22:
Professor W. H. ECCLES, D.Sc., F.R.S.

The College provides practical scientific training for students who desire to become Civil, Mechanical or Electrical Engineers, or Chemists.

Candidates are required to pass an Entrance Examination in Mathematics and English, but the Matriculation Certificate of any British University and certain other qualifications are accepted in lieu of it. The next ENTRANCE EXAMINATION will be held on TUESDAY, SEPTEMBER 19th. Applications for admission should be forwarded to the College on forms to be obtained from the REGISTRAR. The programme of the College is under revision and will be issued shortly. 8468

**University of Birmingham.**
ASSISTANT LECTURER IN CIVIL ENGINEERING, GRADE II.

APPLICATIONS are INVITED for the POST of ASSISTANT LECTURER in the Civil Engineering Department. Commencing stipend £400 per annum.

A good University degree and practical experience of Constructional Engineering are essential.

Applications, with testimonials and references, should be forwarded to the undersigned not later than July 4th.

Further particulars may be obtained from
GEO. H. MORLEY, Secretary.

8490

**Bombay, Baroda, and Central India Railway Co.**

The Directors are prepared to receive up to Noon on Friday, 14th July, TENDERS for the SUPPLY of :—
METALLIC FILAMENT LAMPS.

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 10s. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG, Secretary,

Offices: 91, Petit Franco, Westminster, S.W. 1.
21.6.22. 8558

**County Borough of Brighton.**
TO CONTRACTORS AND OTHERS.

Notice is hereby given that the Council of the said County Borough will receive TENDERS from such persons as may be willing to enter into a CONTRACT for CONSTRUCTING and COMPLETING HEADINGS and BOREHOLES and other WORKS in connection with the Falmer Pumping Station, Falmer, Sussex.

The specification and form of Tender may be obtained on application at my office at the Town Hall, Brighton.

Sealed Tenders addressed to me and endorsed "Tender for Construction of Headings, &c.," must be left at my office at the Town Hall before Ten o'clock in the forenoon on Tuesday, the 4th day of July, 1922.

The Council do not bind themselves to accept the lowest or any Tender. Persons tendering must do so at their own expense.

HUGO TALBOT, Town Clerk.

Town Hall, Brighton,
15th June, 1922. 8508

## The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

The Failure of Civil Aviation.

The Foundry Exhibition.

Institution of Mechanical Engineers: Summer Meeting in France.

A Modern Flour Mill.—No. IV.

The Canadian-Pacific Liner Empress of Australia.

American Research in Metal Welding.

Electric Locomotives.

Recent Developments in Power Station Design.—No. XXXIV.

The East Horndon Railway Accident.

## PUBLIC NOTICES

**Borough of Shrewsbury.**
RECONSTRUCTION OF THE ENGLISH BRIDGE OVER THE RIVER SEVERN.

The Corporation invite TENDERS from public works contractors, experienced in the erection of masonry bridges, for the RECONSTRUCTION of the ENGLISH BRIDGE.

The works include the taking down and rebuilding of the existing masonry in order to reduce the gradient and widen the structure, together with the improvement of the approaches, &c.

Copies of the plans, specification, bill of quantities, and conditions of contract may be obtained on application to the Engineer, Mr. A. W. Ward, A.M. Inst. C.E., Borough Surveyor, at the Guildhall, accompanied by a bank note for £50, which will be returned on receipt of a bona fide Tender and all plans and documents loaned for the preparation thereof.

Sealed Tenders, on the official form, suitably endorsed, and the bill of quantities (under separate cover), fully priced out, must reach me by 10 a.m. on Monday, the 17th July, 1922.

The Corporation do not bind themselves to accept the lowest or any Tender, nor will any allowance or payment be made for the preparation and submission of a Tender.

R. F. PRIDEAUX, Town Clerk.

Guildhall, Shrewsbury,
19th June, 1922. 8530

**County Borough of Halifax.**
HALIFAX CORPORATION ELECTRICITY DEPARTMENT.

The Tramways and Electricity Committee of the Halifax Corporation have FOR SALE the following PLANT :—

2 Babcock and Wilcox WATER-TUBE BOILERS, complete with Chain-grate Stokers.
1 TANDEM COMPOUND STEAM FEED WATER PUMP (J. P. Hall and Son's make).

The above can be inspected by arrangement, and full particulars may be obtained on application to Mr. W. M. Rogerson, M.I.E.E., Borough Electrical Engineer, 29, Northgate, Halifax.

Tenders for the above plant should be delivered to the Town Clerk, Town Hall, Halifax, not later than Saturday, 8th July, 1922.

The highest or any Tender not necessarily accepted.

By Order,
PERCY SAUNDERS, Town Clerk.

Town Hall, Halifax,
10th June, 1922. 8441

**Haslingden, Rawtenstall, and Bacup Outfall Sewerage Board.**
ADDITIONS TO WORKS.
CONTRACT NO. 1.

The Board is prepared to receive TENDERS for the CONSTRUCTION of DETRITUS TANKS, CARRIERS, STORM TANKS, BUILDINGS, and other WORKS at their Sewage Works at Ewood Bridge, Lancashire, in accordance with drawings, general conditions and specification prepared by the Engineer, Mr. G. Midgley Taylor, of Messrs. John Taylor and Sons, 94, Victoria-street, Westminster, S.W. 1.

The specification, bill of quantities and form of Tender may be obtained from the office of the Engineer upon payment of £5 (cheque only), which will be returned upon receipt of a bona fide Tender.

The drawings may be inspected at the offices of the Engineer or at the office of the Clerk to the Board, "West View," Haslingden.

Sealed Tenders, endorsed "Additions to Works," addressed to the Clerk to the Board, are to be delivered at his office at "West View," Haslingden, on or before 10 a.m. on Friday, the 14th day of July, 1922.

The Board does not bind itself to accept the lowest or any Tender.

(Signed) RICHD. WM. BUGLER, Clerk to the Board.

June, 1922. 8515

## PUBLIC NOTICES

**Corporation of Dublin.**
TO MANUFACTURERS OF SEWAGE PUMPS AND ELECTRIC MOTORS.

The Corporation of Dublin are prepared to receive TENDERS for the SUPPLY and ERECTION of TWO SETS of ELECTRICALLY DRIVEN SEWAGE PUMPS, each capable of dealing with 18,000,000 gallons per diem, together with AUXILIARY WORKS, for their Ringsend Pumping Station in the City of Dublin.

The specification may be inspected at the office of the City Engineer, Mr. Michael J. Buckley, 28, Castle-street, Dublin, and at the office of the Consulting Engineer, Mr. John S. Alford, 11, Victoria-street, Westminster, London, S.W. 1, between the hours of 11 a.m. and 4 p.m. (Saturdays excepted), from 26th June. A limited number of copies of the specification, form of Tender, drawing and blank diagram for guaranteed pump performance may be obtained at the aforesaid offices on payment of Five Guineas (crossed cheque only). The deposit will be refunded on the return of the whole of the documents and the receipt of a bona fide Tender.

Tenders, sealed and endorsed on the envelope "Tender for Pumps C1 and D1," are to be addressed to the Chairman of the Streets Committee, Municipal Buildings, Dublin, and must be delivered before Noon on Tuesday, the first day of August, 1922.

With each Tender must be submitted names of two or more sureties, an insurance company or a bank, who will be prepared to execute a joint and several bond for the due performance of the contract in a sum equal to the amount of the Tender.

The specification contains stipulations governing the labour conditions of the contract, and which include the employment of trades union labour, the payment of standard rates for and the observance of standard hours of labour, the employment of local labour, and requiring the use of Irish materials and Irish workmanship, except in cases where they cannot be obtained.

The Corporation do not bind themselves to accept the lowest or any Tender.

JOHN J. MURPHY, Town Clerk, Dublin.

Town Clerk's Office,
City Hall, Dublin,
19th June, 1922. 8545

**East Indian Railway.**

The Directors are prepared to receive up to Eleven o'clock a.m. on Wednesday, the 5th July proximo, TENDERS for the SUPPLY of :—

(1) STEEL MATERIAL.
(2) WROUGHT IRON.
(3) GALVANISED STEEL WORK.

Copies of the specification can be obtained at the Company's offices on payment of £1 1s. This fee will not be returned.

G. E. LILLIE, Secretary.

73/6, King William-street,
London, E.C. 4.
20th June, 1922. 8547

**The Metropolitan Asylums Board** invite TENDERS for the WORK of DREDGING at South Wharf, Rotherhithe, London, S.E. 16, in accordance with specification by Mr. Thomas Cooper, M.I.C.E., Engineer-in-Chief to the Board.

Specification, conditions of contract and form of Tender may be obtained at the office of the Board, Embankment, E.C. 4.

Tenders, addressed as noted on the form, must be delivered at the office of the Board not later than 10 a.m. on Thursday, 6th July, 1922.

G. A. POWELL, Deputy Clerk to the Board.

19th June, 1922. 8533

## PUBLIC NOTICES

**Goole Urban District Council**
(GAS AND WATER DEPARTMENT).
PUMPING PLANT, &c.

The above Council invite TENDERS for a PLANT capable of pumping 50,000 gallons of water per hour from a proposed 36in.-bore-hole at their Pollington Waterworks to the Water Tower at Goole.

And alternatively TENDERS for SINKING a BORE-HOLE 420ft. deep in their No. 3 Well and PROVIDING and FIXING a BORE-HOLE PUMP with a capacity of 50,000 gallons per hour; also for a WATER TOWER at Goole with a capacity of 750,000 gallons and the bottom of the tank or tanks thereof 120ft. above the ordinary top water level of the Knottingley and Goole Canal; also for DEEPENING Nos. 1 and 2 WELLS and the ADITS between Nos. 1, 2 and 3 WELLS, and ALTERING the existing PUMPS to lift from a greater depth.

Further particulars may be obtained from the undersigned.

ARTHUR F. YATES, Engineer and Manager.

Gasworks, Doyle-street, Goole,
21st June, 1922. 8569

ERECTION OF VALVE TOWER AND OTHER WORKS.

**The Corporation of Dublin is** prepared to receive TENDERS for the CONSTRUCTION of a VALVE TOWER and other WORKS for the New Reservoir at Roundwood, Co. Wicklow.

Copies of the drawings and specifications may be seen at the Borough Surveyor's Office, 28, Castle-street, Dublin, between the hours of 11 a.m. and 4 p.m. on and after the 21st June, and copies may be had on payment of a sum of £1, which will be refunded on the receipt of a bona fide Tender. All work shall be done by members of Irish trade unions.

The Corporation does not bind itself to accept the lowest or any Tender. No Tender will be considered unless it is furnished on the Tender form provided.

Sealed Tenders, accompanied by drawings and specifications, endorsed "Tender for Construction of Valve Tower, New Reservoir, Roundwood, Co. Wicklow," should be addressed to the Chairman Waterworks and Markets Committee, Municipal Buildings, Cork-hill, Dublin, and should be delivered not later than Noon on Tuesday, 4th July, 1922.

By Order,
JOHN J. MURPHY, Town Clerk.

21st June, 1922. 8564

**Aberdeen Waterworks.**
WATERWORKS ASSISTANT WANTED IMMEDIATELY; thoroughly experienced in the design and construction of Aqueducts and Reinforced Concrete Work. Salary £300. Send testimonials, chronological statement of career, age, and state of health, &c.
GEORGE MITCHELL, M. Inst. C.E., Water Engineer.

8541

AN EXCEPTIONAL "BUSINESS OPPORTUNITY."

TAKE THE LONG VIEW FOR TRADE REVIVAL.

**For Sale as a Going Concern,** one of the most complete and best equipped

ENGINEERING WORKS

in the South of England, recently valued at over £130,000.

Some proportion of the purchase money would be allowed to remain on mortgage, provided vendor is satisfied that adequate working capital will be provided.

Principals only address 8567, The Engineer Office. 8567

PUBLIC NOTICES (continued) Page II.

SITUATIONS OPEN, Page II.

SITUATIONS WANTED Pages II. and III.

PATENTS, Page III.

MACHINERY, &c., WANTED Page III.

FOR SALE, Pages IV. and VIII.

AUCTIONS, Pages IV. and CII.

PREMISES TO LET OR WANTED Page IV.

WORK WANTED, Page VIII.

AGENCIES, Page III.

MISCELLANEOUS, Page III.

*For Advertisement Rates See Page 697, col. 1.*

NUMERICAL INDEX TO ADVERTISEMENTS, Page CI.

## PUBLIC NOTICES

### The Great Indian Peninsula

RAILWAY COMPANY.

The Directors are prepared to receive TENDERS for the SUPPLY of the following STORES, namely :—

| No. | | Fee for Specification. |
|---|---|---|
| 1. | SPARE PARTS of CARRIAGES and WAGONS (W.I. AXLE GUARDS, &c.) | £1 |
| 2. | SPARE PARTS of CARRIAGES and WAGONS (BUFFERS, &c.) | £1 |
| 3. | WHEELS and AXLES (FORGINGS) | £1 |
| 4. | HELICAL and VOLUTE SPRINGS | £1 |
| 5. | LAMINATED SPRINGS | £1 |
| 6. | AXLE-BOXES | £1 |
| 7. | STEEL WORK for BRIDGES | 10s. |

Specifications and forms of Tender may be obtained at this office on payment of the fee for the specification, which payment will not be returned.

The fee should accompany any application by post. Cheques and postal orders should be crossed and made payable to the Great Indian Peninsula Railway Company.

Tenders must be delivered in separate envelopes, sealed and addressed to the undersigned, marked "Tender for Spare Parts of C. and W. (Axle Guards, &c.)," or as the case may be, not later than Eleven o'clock a.m. on Tuesday, the 4th July, 1922.

The Directors do not bind themselves to accept the lowest or any Tender.

R. H. WALPOLE,
Secretary.

Company's Offices :
48, Cornhill-avenue, E.C. 2.
London, 21st June, 1922. 8565

### The South Indian Railway Company,

LIMITED, are prepared to receive TENDERS for the SUPPLY of :—

1. WROUGHT IRON.
2. GALVANISED CORRUGATED SHEETS.
3. STEEL RAILS and FISH-PLATES.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tenders for Wrought Iron," or as the case may be, must be left with the undersigned not later than Twelve Noon on Friday, the 7th July, 1922.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 10s. for each copy of Specifications Nos. 1, 2 and 3.

Copies of the drawings may be obtained at the office of Messrs. Robert White and Partners, Consulting Engineers to the Company, 3, Victoria-street, Westminster, S.W.

A. MUIRHEAD,
Managing Director.

91, Petty France, S.W. 1.
21st June, 1922. 8576

### Bombay Municipality.

REQUIRED, ONE MECHANICAL ENGINEER and THREE ASSISTANT MECHANICAL ENGINEERS, to Supervise the Manufacture of 72in., 90in., and 57in. diameter Steel Pipes in the Workshops near Bombay, and the Assembling and Laying of the same along 60 miles of pipe track outside Bombay.

All applicants should be between 35 and 45 years of age.

The Mechanical Engineer should have had a good technical education and considerable practical experience in structural steel work, boilermaking, &c., and have held a responsible position as works manager, shift engineer, or similar post in a shipyard, railway, or large commercial firm.

Assistant Engineers should have had similar experience in a less responsible position, such as works foreman or foreman boilermaker, &c.

The salary for the Mechanical Engineer is Rs. 1500 per month, without quarters. The salary for the Assistant Engineer is Rs. 800 per month, with tent or quarters and simple furniture; no accommodation is provided for wife or family.

All the appointments are temporary, but are not expected to terminate within three years.

The salary will commence from date of joining appointment in Bombay, and single first-class rail fare to Bombay will be paid to applicants selected from India.

Single first-class P. and O. passage from London to Bombay for the Mechanical Engineer, and second-class P. and O. passage for the Assistant Engineers will be provided if applicants are selected from the United Kingdom, with half salary on voyage.

Similar return passages and half salary on voyage being allowed on satisfactory completion of their duties.

All appointments are subject to three months' notice on either side.

All selected candidates will be required to furnish a medical certificate of sound health and constitution prior to engagement. They will be entitled to leave according to the Municipal Leave Rules.

Selected candidates will be required to enter on their duties in Bombay early in December, 1922.

Applications, stating age, qualifications and experience, together with copies of testimonials, should be addressed to the undersigned and will be received up to 31st August, 1922.

H. J. THIVESS SMITH, M.I.C.E.,
Hydraulic Engineer.

C/o Messrs. Henry S. King and Co.,
9, Pall Mall, London, S.W. 1. 8523

### Singapore, Straits Settlements.

WATER DEPARTMENT.

ASSISTANT SUPERINTENDENT OF WATER MAINS AND SERVICES.

The Municipal Commissioners of Singapore REQUIRE an ASSISTANT SUPERINTENDENT of WATER MAINS and SERVICES, age about 27 to 35 (preferably unmarried), on a three years' agreement, with possible extension. Applicants must have had a good education, be well trained and have had special practical experience in the laying of water mains and outside water fittings, as well as internal plumbing. They must be "Registered Plumbers," with experience in the work of a mains and services department under a water authority in the United Kingdom, and must be accustomed to carrying out the model by-laws and regulations. They should be accustomed to controlling men, and experience in a workshop and in training men will be an advantage, as the successful candidate would be required to instruct the native subordinate staff in the practice and requirements of modern internal plumbing for public and private buildings. He would also be required to supervise such work in accordance with standard regulations, whether executed by outside contractors or by municipal workmen. A bonus of 50 dollars will be given on the selected candidate's passing successfully an examination in colloquial Malay within twelve months of his arrival in Singapore. Salary 4560 dollars for the first, 5040 dollars for the second, and 5520 dollars for the third year, paid monthly in dollars the currency of the Colony, the value of the dollar being two shillings and fourpence sterling. In addition there is a temporary allowance of 15 per cent., which may be reduced or abolished at any time. If re-engaged, the candidate, in his fourth year, would probably be placed in Class 5 of the salary scheme, at a commencing salary of 6000 dollars per annum (£700), rising by annual increments of 480 dollars to 7440 dollars (£868) per annum, with any temporary allowance that might then be in force. The pay of the appointment for the first year at the above rate would be about £911. Such local transport allowance as may from time to time be sanctioned by the Commissioners will be paid. Free second-class passage will be provided, with half-pay during the voyage out. The selected candidate must pass a medical examination. Applications, stating whether married or single, age, and place of birth, and giving details of education, apprenticeship, training, and experience generally, with war service, and referring to the above requirements in detail, accompanied by copies (only) of testimonials, and also personal references, are to be lodged with Messrs. C. C. LINDSAY and PEIRCE, MM. Inst. C.E., 180, Hope-street, Glasgow, Agents to the Commissioners (who will give further particulars if requested), not later than Thursday, 6th July, 1922.

8519 x

WANTED, Bound or Unbound, VOLUMES of "THE ENGINEER" from July, 1914, to June, 1919.—Address, stating lowest price, P1000, The Engineer Office. P1000 x


# Edward Arnold & Co.'s Book List.

*Just Published.*

## RAILWAY ELECTRIC TRACTION.

By F. W. CARTER, M.I.E.E.

British Thomson-Houston Company, Rugby. 400 pages, with 204 Diagrams, Photos and Plates. 25s. net.

The author starts with a survey of the different systems of electrification and draws a comparison between steam and electric working under various conditions. He then describes the locomotive, distribution systems, etc., in detail, and develops the mathematical calculations necessary for dealing with the various problems which arise.

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## HYDRAULICS. For Engineers & Engineering Students.

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**London: EDWARD ARNOLD & CO., 41 and 43, Maddox St., W. 1.**


## SITUATIONS OPEN

WANTED, a TECHNICAL EXPERT, to Advise on new plant for the Manufacture of Sheet Glass.—Full particulars to W. J. PERKINS, A.M. Inst. C.E., M.I. Mech. E., Consulting Engineer, 26, Victoria-street, Westminster, S.W. 1 P5626 A

A SUCCESSFUL ENGINEERING COMPANY in London REQUIRES a MAN with a sound theoretical training and good practical experience of Sheet Metal Working, Foundry and Machine Shop Practice, to TAKE FULL CONTROL of PRODUCTION and ultimately to JOIN its BOARD. Whilst the position offers excellent prospects for the right man, the duties are onerous, requiring great tact, thorough mastery of detail, and the ability to lay out and organise new departments. Therefore only those who are confident that they possess these qualifications and are prepared to face a great deal of hard and harassing labour should apply.

Applicants, in addition to the usual particulars, are requested to state what salary they would require, as no scale has been fixed at present.

Answers should be in the applicant's own handwriting.

Investment is by no means essential or desired by the Company, but could be arranged for after a probationary period.

Address, P5597, The Engineer Office. P5597 A

FIRM of ENGINEERS, FOUNDERS and MERCHANTS and AGENTS in India have an OPENING for ASSISTANT to MANAGING DIRECTOR, who, at times, would have to take control of business; fully qualified engineer, one with foundry and electrical knowledge preferred, who could take part in the salesmanship and commercial side of the business. Must be well educated and of good manners and excellent character. State experience.—Address, P5619, The Engineer Office. P5619 A

OLD-ESTABLISHED REINFORCED CONCRETE ENGINEERS REQUIRE an ASSISTANT with some experience in design. State age and experience and salary required.—Address, P5582, The Engineer Office. P5582 A

THE SERVICES of a Competent GENTLEMAN are REQUIRED for the POST of CHIEF ENGINEER at a large Iron and Steel Works near the East Coast. In making the selection preference will be given to men who have had thoroughly practical experience in the economic running of sheet bar mills. Applicants should also have had experience in modern coke oven, blast-furnace and steel furnace design and maintenance, as well as all auxiliary plant pertaining thereto.

Only thoroughly live men need apply. Suitable house available.

Applications, giving age, experience, and salary required, together with recent references.

Address, 8557, The Engineer Office. 8557 A

PROVINCIAL AGENT.—A LONDON FIRM is Open to receive APPLICATIONS for the REPRESENTATION of their STEAM POWER SPECIALTIES (Superheaters, Patent Dampers, Steam and Water Meters, &c.). Only those with established connection amongst steam sets will be entertained.—Address, 8534, The Engineer Office. 8534 A

WORKS MANAGER for Small Engineering Works. Knowledge and experience of Welding and Steam Fitting Manufacture essential. State experience, age, and salary required. Copies only of testimonials.—Address, 8531, The Engineer Office. 8531 A

WANTED, a DRAUGHTSMAN, Experienced in the Design of Colliery Screening Plant. Apply, stating age, experience and salary required, to NORTONS (Tividale) LIMITED, Heela Works, Tipton. 8573 A

WANTED AT ONCE, First-class DRAUGHTSMAN, thoroughly experienced in the Design of all sizes of Electric Cranes. Preference given to one who has had considerable practice in estimating. State age, experience, and salary required.—Address, 8536, The Engineer Office. 8536 A

WANTED, CHIEF DRAUGHTSMAN by Firm of General Engineers in the Midlands, accustomed to control of office routine and experienced in Hydraulic and General Engineering.—Address, stating age, experience, and salary required, 8539, The Engineer Office. 8539 A

WANTED, DESIGNING DRAUGHTSMAN, Capable of developing new line of Centrifugal Pumps. Must be technically trained and capable of assuming full charge of work. Location, Lancashire. State age, education, practical experience, and salary expected.—Address, 8529, The Engineer Office. 8529 A

## SITUATIONS OPEN (continued)

WANTED, Fully Qualified AUTOMOBILE DRAUGHTSMAN. Preference will be given to applications from men who have specialised in commercial vehicle design.—State age, experience and salary expected to Box No. C.M. 340, c/o Dawson's, 121, Cannon-street, E.C. 4. 8477 A

DRAUGHTSMAN.—WANTED on N.E. Coast, in large Constructional Works, first-class DRAUGHTSMAN with latest modern blast-furnace experience. No application except from men with this experience will be considered. Good wages to right man.—Address, 8512, The Engineer Office. 8512 A

DRAUGHTSMAN REQUIRED, North-East Coast. Must be thoroughly competent on all classes of Structural Work and Bridge Work; age 30 to 40. Full particulars, stating salary required.—Address, 8577, The Engineer Office. 8577 A

FIRST-CLASS DRAUGHTSMAN WANTED. Must have had wide experience and shop training; some experience of aeroplane work desired.—Address, 8551, The Engineer Office. 8551 A

WANTED, BOILER SHOP FOREMAN for Shop of 60 hands. Must be competent to take full charge of manufacture of all classes of boiler work from beginning to end; electric and acetylene welding, press work, machine work.—Address, 8568, The Engineer Office. 8568 A

BRASSFOUNDRY FOREMAN REQUIRED. Applicants must be accustomed to controlling men and be capable of getting the maximum output at a minimum of cost. Present output 10 tons per week.—Address in confidence, stating age and experience, 8518, The Engineer Office. 8518 A

## SITUATIONS WANTED

AS WORKS MANAGER, Thoroughly Practical, well educated ENGINEER, with sound experience in loco., steam, general engineering, millwrighting, ironfoundry and repair work. Past 23 years successful control of labour as foreman and works manager.—Address, P5608, The Engineer Office. P5608 B

ASSISTANT TO WORKS MANAGER, &c.—ADVERTISER, good mathematician, with extensive practical engineering experience, OFFERS HIMSELF as EXPERT in Planning and Progress Work, also Piecework.—Address, P5606, The Engineer Office. P5606 B

BUYER.—The MANAGER of a Large Engineering Works Purchasing Dept., who has an exceptionally wide knowledge of the markets of the country, DESIRES to NEGOTIATE NEW APPOINTMENT.—Write, Z. M. 613, c/o Deacon's, Leadenhall-st., E.C. 8494 B

COST ACCOUNTANT SEEKS RE-ENGAGEMENT. Several years' charge experience; moderate salary.—WILLIS, 18, Appach-road, Brixton, S.W. 2. P5596 B

CIVIL ENGINEER, B.Sc., SEEKS POST with possibilities of advancement. Six years public school, four years' war service, past two years with firm of consulting engineers. First-class testimonials. Very keen and good organiser; age 28; fluent French and practical knowledge of German.—Address, P5629, The Engineer Office. P5629 B

CIVIL ENGINEER, M.I. MECH. E. SEEKS ENGAGEMENT ON MANAGEMENT OF CONSTRUCTION OF NEW WORKS; ANY DISTRICT.—Address, P5621, The Engineer Office. P5621 B

CIVIL ENGINEER (36), Lieut., R.E. (R. of O.), 12 years' experience railway engineering (survey, construction, maintenance and allied works), REQUIRES APPOINTMENT. Experience in Chile, Brazil, Nigeria, Gold Coast, France and Belgium. &c. Speaks Spanish, Portuguese and knowledge French. Excellent testimonials testifying as to ability, general conduct, discipline, tact, energy, control of labour, &c.—Address, P5604, The Engineer Office. P5604 B

ENGINEER, Age 44, Apprenticed to Fitting, Turning and pattern-making, 18 years drawing-office, 3 years works manager, crane and general work, DESIRES ENGAGEMENT as Manager, Draughtsman or Traveller.—Address, P5616, The Engineer Office. P5616 B

## SITUATIONS WANTED (continued)

ENGINEER, A.M.I.M.E., M.I.A.E., &c., with London office, is OPEN to REPRESENT MANUFACTURERS or act as English Agent for continental firms engaged in engineering and allied trades or specialities. Inquiries invited.—Write, WILLIAM A. COFFEY, 4, Devonshire-chambers, 146, Bishopsgate, London, E.C. 2. P5275 B

ENGINEER (A.M.I.C.E., A.M.I. Mech. E.), Thirty-two, with some capital, fund mechanical and works management experience, SEEKS OPENING in established business with prospective interest or partnership.—Address, P5627, The Engineer Office. P5627 B

ENGINEER (British), Energetic, with Varied Experience, practical, technical and commercial, WISHES LONDON AGENCY for progressive firm, British or foreign; conversant also French and Spanish languages.—Address, P5617, The Engineer Office. P5617 B

ENGINEER, Discharged, SEEKS POSITION, Home or abroad; 1st Class B. of T. certificate, I.C.E. engineers' diploma.—JOHANSON, 27, Rose-street, Gateshead. P5579 B

ENGINEER (Junior), 23, DESIRES APPOINTMENT; thorough practical knowledge of technical details, 4 years workshops, good draughtsman and mathematician; constructional work preferred.—BARTLETT, 13, Ridgeway, Edgbaston, Birmingham. P5586 B

ENGINEER, M.I.M.E., A.M.I.C.E. (41), with Extensive experience in mining, railway, docks and contractors' plant and machinery, is OPEN to REPRESENT a few FIRMS in London.—Address, P5599, The Engineer Office. P5599 B

ENGINEER (30), Married, Ex-Service, Public School education, 12 years' practical and commercial experience, England and America, shop management, steam, internal combustion, electric, maintenance of factory plant, knowledge of refrigeration, accounts, typing, general office work, DESIRES POSITION, any capacity; moderate salary.—Address, P5555, The Engineer Office. P5555 B

ENGINEER SEEKS APPOINTMENT Ashore; Age 30, good references, first-class certificate of competency; strictly sober; time served on general all round work.—Address, P5612, The Engineer Office. P5612 B

ENGINEER SEEKS POSITION of Permanent character in good firm of consulting marine engineers. Holds B. of T. chief engineer's certificate; has had experience in Diesel work, supervision of repairs to machinery, boilers and ships, and since October, 1919, has represented a firm of consulting marine engineers on the Continent. Willing to invest capital.
Address, P5587, The Engineer Office. P5587 B

ENGINEER, with Wide Experience of Works and foundry management, also general organisation, both for mass production or order type, is OPEN for TEMPORARY ENGAGEMENT to take over or assist in reorganisation or similar work.—Address, P5609, The Engineer Office. P5609 B

ENGINEER (36), Late Manager Small Works, Charge D.O. 7 years, general engineering, steam, petrol, plant, railway tracks, SEEKS any POST anywhere. Moderate salary.—Address, P5605, The Engineer Office. P5605 B

ENGINEER (37). Over 23 Years' Exp. of Trade, last 12 as foreman of machining, fitting, tool shops, SEEKS BERTH in or near London. Used to general and repetition work; good organiser, up-to-date; mod. salary, good references.—Address, P5600, The Engineer Office. P5600 B

ENGINEER, with Wide Experience in Designing of factory labour-saving machinery and devices, shortly DISENGAGED. Strongly recommended. British or American firms please communicate.—Address, P5614, The Engineer Office. P5614 B

ENGINEERS and STEEL MANUFACTURERS Will note that a SALESMAN with large connection in the Midlands is OPEN for RE-ENGAGEMENT.—Address, P5581, The Engineer Office. P5581 B

HEAT TREATMENT SPECIALIST DESIRES EMPLOYMENT; good organiser, excellent recommendations.—Address, P5593, The Engineer Office. P5593 B

LABOUR SUPERINTENDENT REQUIRES SIT., any district. Thoroughly exp. interviewing, engaging and discharging workpeople engineering factories, keeping records, insurance, compensation, &c. Conversant with Fed. rates, rules, &c.; age 32.—Write, A. V. O., 59, Arcllife-road, Wormholt-road, Shepherd's Bush, London. P5602 B

MECHANICAL and MARINE ENGINEER and DRAUGHTSMAN (39) DESIRES SITUATION at moderate salary. Apprenticeship with Messrs. Vickers Ltd. (naval constructors), 5 years fitting, machine, erecting shops and engine trial running, 4 years sea-going engineer, and 4 years mechanical draughtsman; excellent testimonials.—Address, P5619, The Engineer Office. P5619 B

MECHANICAL ENGINEER, Age 19, Just Completed three years' apprenticeship in engineering workshop, excellent references, now studying R.N.C. engineering, public school education, REQUIRES one or two years' EXPERIENCE in good Mechanical Engineer's Drawing-office. Salary not essential.—Address, 8548, The Engineer Office. 8548 B

MECHANICAL ENGINEER (29), Single, B.O.T. first certificate and subject exams, experience includes marine chief engineer and consulting, London, for steam, electrical, I.C., workshop machinery, &c., excellent training and references, SEEKS PRACTICAL JOB, production or maintenance.—BERRY, 99, Leadenhall-road, Tottenham, London. P5625 B

MECHANICAL ENGINEERING DRAUGHTSMAN IMPROVER, diligent, ambitious and reliable, DESIRES SITUATION, home or abroad; age 25, single, ex-Service.—Address, P5595, The Engineer Office. P5595 B

SALES ENGINEER.—REQUIRED, POSITION as above or similar commercial post by B.Sc., civil and mechanical engineering; 21 years of age; excellent references.—Address, 8574, The Engineer Office. 8574 B

SCOTTISH ENGINEER (28) SEEKS ENGAGEMENT as Manager or Assistant; works management experience at home and abroad; knowledge Portuguese and Spanish; shortly free.—Address, P5601, The Engineer Office. P5601 B

TRAVELLER (33), Technical Man, Constructional engineering, DESIRES CHANGE; over 10 years with present firm (one of the largest in the country); sound connection Midlands, Lancashire, Yorkshire and Cheshire.—Address, P5618, The Engineer Office. P5618 B

WORKS MANAGER, 39 Years, Had Shop and commercial training, boiler, foundry, machine and electrical depts., expert in hydraulic and mechanical pressings, efficient on production costing and time keeping, capable of relieving board of directors, SEEKS ENGAGEMENT; Midlands or South preferred.—Address, P5603, The Engineer Office. P5603 B

MECHANICAL DRAUGHTSMAN, with Wide Experience in the design and lay-out of various industrial plants, power station design, and general engineering, DESIRES SITUATION; London or South Coast.—Address, P5578, The Engineer Office. P5578 B

**For continuation of Small Advertisements see page iii**

# Developments in Power Station Design.

No. XXXIV.*

Two types of boilers which ought to have been dealt with in an earlier article, but which had to be neglected for the time being on account of the drawings not coming to hand, are the Niclausse and Spearing boilers, which are made by the Niclausse Boiler Company, Limited, and the Spearing Boiler Company, respectively. Several important stations in this country and a good many on the Continent have recently been equipped with the Niclausse boiler. Although this type of steam generator has been used mainly for marine work in sixteen different navies, it is quite suitable for use on land, especially where it is desired to save floor space, and boilers with an aggregate capacity of 2,000,000 horse-power have, we are told, been erected for this class of service.

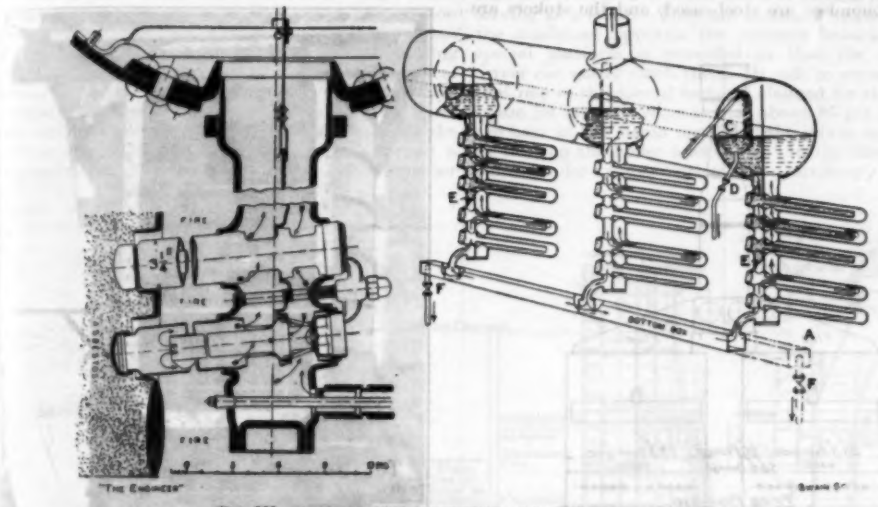


FIG. 222—DETAILS AND PRINCIPLE OF NICLAUSSE BOILER

Various improvements have been made during recent years in the design of the boiler without affecting the broad principle upon which it is built. The characteristic features are, of course, the use of single headers, coned metal-to-metal joints instead of expanded joints, and circulating tubes within the evaporating tubes, which are closed at the back by means of screwed caps or are nosed over solid. At the opposite end—see the drawing on the left of Fig. 222—

*No. XXXIII. appeared June 9th.

the evaporating tubes have three local swellings, two of which, namely, the front and rear swellings, are machined to gauge so that they correspond with the conical seats in the back and front walls of the header. Between the tube swellings two ports are cut to correspond with the front and back part of the headers, which are divided by a vertical diaphragm, and the function of the centre swelling is to close the hole in the diaphragm through which the tube passes. The front cone is rigid, but the back one is flexible, and is made so that it engages with its seating in the header before the front cone engages with its seating, and on pushing the tube, by means of an easily manipulated tool, the back cone yields until ultimately both cones form a sound joint which will withstand the highest pressures at present in use. The inner tubes are made of thin steel strip, and at the end remote from the header, each tube is provided with a light spider which keeps it centralised in the outer evaporating tube.

To the outer end of each of the inner tubes a cup is riveted. This cup just fits inside the outer tube, and separates the two ports from each other. For the purpose of retaining the inner tube in position a light bridge piece is riveted across the mouth of the cup, and is loosely attached to the screwed conical plug which closes the end of the big outer tube. The water descending in the front part of the header enters through the front port of the inner tube, and in passing through this tube the water absorbs a considerable amount of heat. It then returns by way of the annular space between the inner and outer tube, and escapes with the steam that is generated through the other port at the rear portion of the header and back into the drum. It is claimed that positive and very rapid circulation is thereby ensured, and that steam can be raised rapidly without risk of trouble, the tubes being perfectly free to expand at the back end.

By means of three special tools, which can easily be manipulated by unskilled labour, the inner and outer tubes can be removed and replaced in about three minutes. Moreover, the withdrawal of a tube does not involve its destruction as is the case of an expanded tube, and it is therefore possible to withdraw tubes for inspection and cleaning. The headers, which are composed of solid drawn steel tubes of rectangular section, are designed either for two or three rows of tubes, according to the class of service and duty for which the boiler is required. At the upper end the headers are circular, so that joints can be made with the steam drum, which has a stout saddle provided with a number of conical holes. The circular ends of the headers are turned to fit these holes, and the joint is tightened up by bolts passing through collars screwed to the header, the bolt heads being coned and fitting into reamered holes. In order to free the feed water from air it is injected into the steam space against baffles, and it then falls into a detartarising trough C which extends throughout the length of the drum, and the water is distributed evenly all over the headers. This method of injecting the feed water is claimed to greatly diminish the risk of tubes deteriorating.

Generally speaking, it is sufficient to remove the front plugs of the tubes and to take out the inner tubes once a year for the purpose of washing them out by means of a hose. During recent years the makers have introduced a special system of feed distribution, which is designed to serve the lower tubes, which are, of course, those nearest the furnace, and are consequently the principal evaporating tubes. The steam and water drums are divided into two compartments by a longitudinal diaphragm plate in line with the vertical partitions in the headers, and, after the feed water has passed through the trough in which the carbonates and other impurities are precipitated and from which they are ejected by a blow-down valve D, it enters the front compartment of the drum, and then descends in the headers for a certain distance, which is determined by the diaphragm E in Fig. 222. It then passes by way of the tubes into the back compartment of the drum, which consequently only contains purified

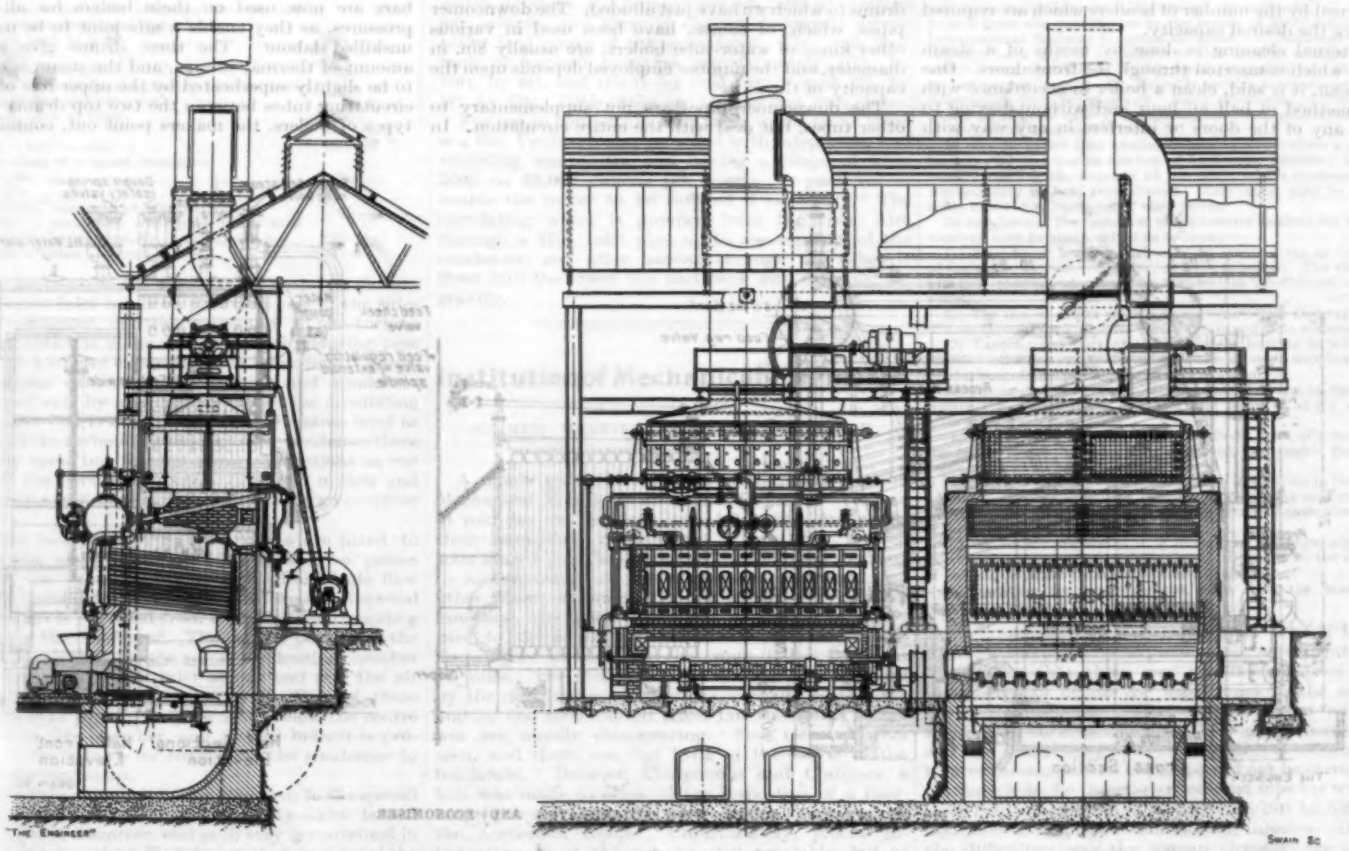


FIG. 223—NICLAUSSE BOILERS IN THE ROTHERHAM POWER STATION

feed. In the case of high-duty boilers the feed then descends by way of two tubes in front of the side walls into a square horizontal header arranged in front of the vertical headers. The upper tubes are therefore fed by relatively cold and partially purified water, and the bottom tubes by purified hot water at the boiler steam temperature. The horizontal header also serves as a box to which draining valves F can be connected.

As the lower tubes receive the feed at boiler steam

temperature, they do not, the makers point out, receive impurities which can cause a deposit. Any impurities in the feed water within the upper tubes are practically harmless because the temperature of the gases outside these tubes is insufficient to form a hard scale.

The Niclausse boilers, like many other forms of boilers, are fitted with an economiser, which is placed above the tubes, and the water circulates in the economiser on the contra-flow principle, that is to say, in the reverse direction to the flue gases. Superheaters are also fitted above the evaporating tubes, but below the superimposed economiser, and where the temperature is relatively low, so as to ensure that the parts have a long life. The makers claim that the weight of the boiler and the amount of brickwork required are considerably less than those of other water tubes of the same capacity. The largest part of the boiler is the drum, which has a diameter of 1 m., whilst the width of the boiler is, of course, governed by the number of headers which are required to give the desired capacity.

External cleaning is done by means of a steam lance which is inserted through the front doors. One man can, it is said, clean a boiler in accordance with this method in half an hour and without having to open any of the doors or interfere in any way with the operation of the boiler. Another advantage of this type of steam-raising unit is that it has an exceptionally high capacity per square foot of ground space and per cubic foot of space occupied. In all cases the depth and height of the boiler are constant, the width alone varying with the capacity required. As all the parts can be withdrawn entirely from the front, the boilers can be placed back to back, and an exceptionally compact boiler-house can be secured in that manner. The general arrangement of two Niclausse boilers, each having a capacity of 30,000 lb. of steam per hour, and working at a pressure of 200 lb, is shown in Fig. 233, these boilers having been erected in the Rotherham Corporation station during the war. One of the most recent Niclausse installations is at Blackpool. The boilers in this case are designed to evaporate 35,000 lb. of steam per hour, the steam pressure being 250 lb. per square inch. Each boiler is fitted with Erith-Roe stokers, economisers and superheaters, which give a superheat of 200 deg. Fah.

A 25,000 lb. cross-drum boiler of the Spearing type, fitted with a superheater and separate vertical pipe economiser, and designed for a working pressure of 260 lb. per square inch and a total steam temperature of 650 deg. Fah., is shown in Fig. 225 The boiler and economiser are steel-cased, and the stokers are of the Bennis chain grate type. There are two steam and water drums at the upper part of the boiler, and a single drum at the bottom. The distinctive features of the boiler to which the makers direct particular attention are :—(1) The downcomer pipes ; (2) the straight headers ; (3) the large access and exit passages from the individual headers ; and (4) the three drums to which we have just alluded. The downcomer pipes, which, of course, have been used in various other kinds of water-tube boilers, are usually 8in. in diameter, and the number employed depends upon the capacity of the unit.

The downcomer pipes are not supplementary to other tubes, but deal with the entire circulation. In conjunction with the mud drum, it is claimed that they give continuous and free circulation to the steam-generating tubes over the fire at all rates of evaporation, an ample supply of water to the latter being thus ensured. As the three rows of tubes nearest the fire generate more than half of the steam, it is claimed that by feeding these tubes first in the manner shown, bulging, perforation and hogging of the tubes are reduced to negligible proportions. Another advantage claimed for the downcomer pipes is that in conjunction with the straight headers and the large inlet and outlet nipples connected to the headers, the safe steaming capacity of the boiler is increased. The nipple tubes which connect the headers with the drums are 4½in. in diameter, which is equivalent to an area of about 14 square inches, or an increase of 28 per cent. as compared with the area of the usual 4in. nipples. This increase in area, the makers contend, is very desirable when the boiler is working at high evaporating rates.

Before the feed water can reach any of the relatively small generating tubes, it must pass through the large downcomer pipes and the mud drum which traps the deposits, and if the water is liable to cause corrosion the thick downcomer pipes and mud drum are more likely to be affected than the steam generating tubes. The straight solid-drawn headers are claimed to present less resistance than usual to the circulation of steam and water. Internal caps and external cross bars are now used on these boilers for all steam pressures, as they enable a safe joint to be made by unskilled labour. The three drums give a large amount of thermal storage, and the steam is claimed to be slightly superheated by the upper row of steam circulating tubes between the two top drums. Some types of boilers, the makers point out, contain relatively small quantities of water, and in the event of severe tube or joint leakages or unnoticed stoppage of the feed pump whilst the boiler is developing its full output, the water is liable to be exhausted in a very short space of time. The standard length of the tubes in these boilers is 18ft., whilst the diameter is 4in., but the design may be varied to suit individual conditions. The separate economiser is composed of wrought steel, and the tubes are ¼in. thick.

The boilers are fitted with Ferguson economisers, which are so designed that each section, which is composed of three or four tubes, is detachable and can be withdrawn without interfering with the tubes

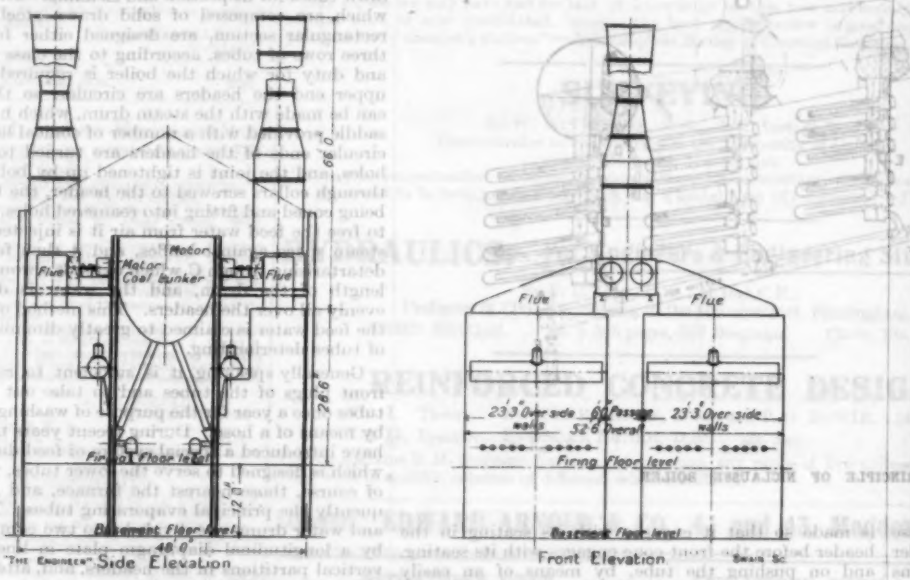



FIG. 224—ARRANGEMENT OF NICLAUSSE BOILERS IN A POWER HOUSE

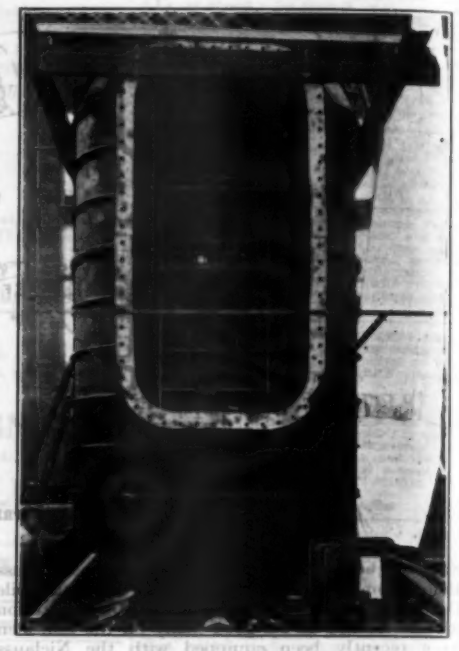


FIG. 226—CONDENSER FOR USE WITH DELAS AIR EXTRACTORS

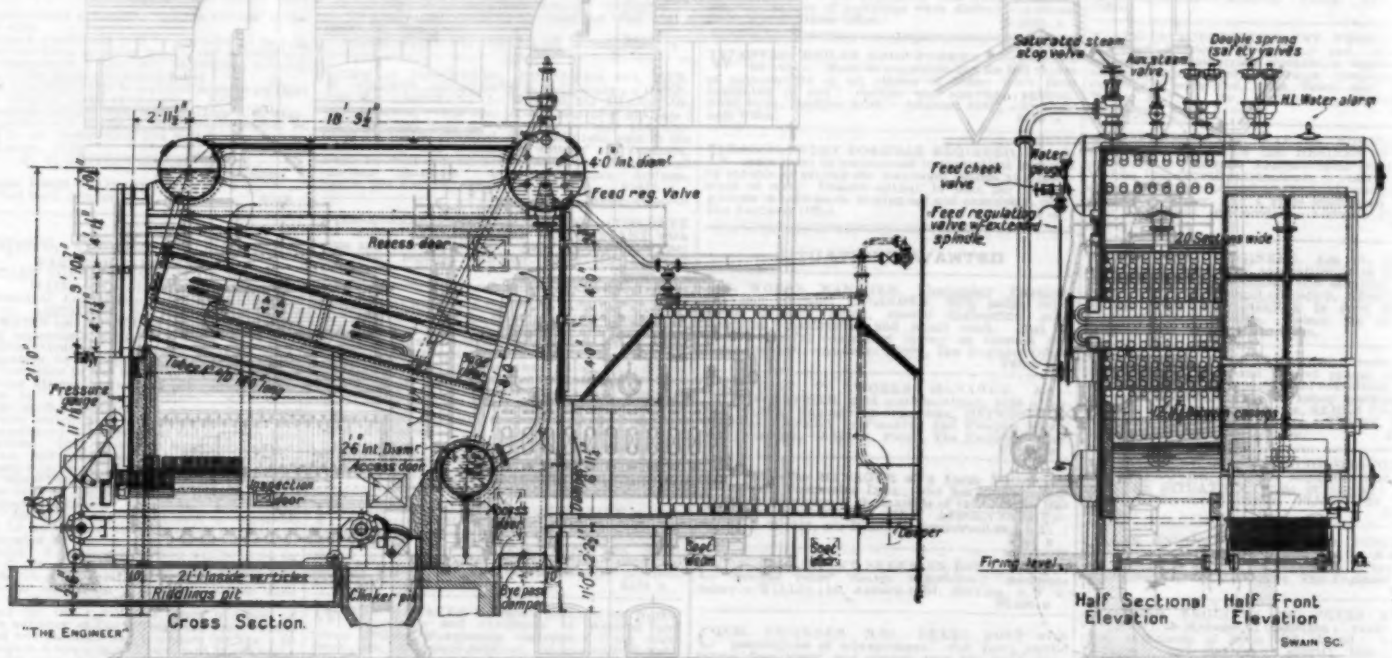



FIG. 225—SPEARING BOILER WITH SUPERHEATER AND ECONOMISER

belonging to other sections. The tubes are expanded into 1in. machined wrought iron plates, which are attached to the boxes by means of studs and nuts, the joints being made with corrugated copper rings, asbestos and paste.

In our issue of May 12th we described the Delas air extractors for removing the air from condensers, and also a jet condenser fitted with these extractors. A very much larger condenser of the surface type has, however, been built and equipped with Delas air extractors in the works of Cole, Marchent and Morley, Limited. This condenser, which is shown in Figs. 226 and 227, has been constructed to the order of the Leeds Corporation and is to be used in conjunction with a 12,000-kilowatt B.T.H. turbo-generator set at the Corporation's Whitehall-road electric lighting station. The shell, it will be noticed, is of the vertical instead of the usual horizontal type. The condenser is capable of dealing with 220,000 lb. of steam per hour and of maintaining a vacuum of 28.5in. with the barometer at 30in. and with the cooling water at a temperature of 65 deg. Fah. In all the condenser

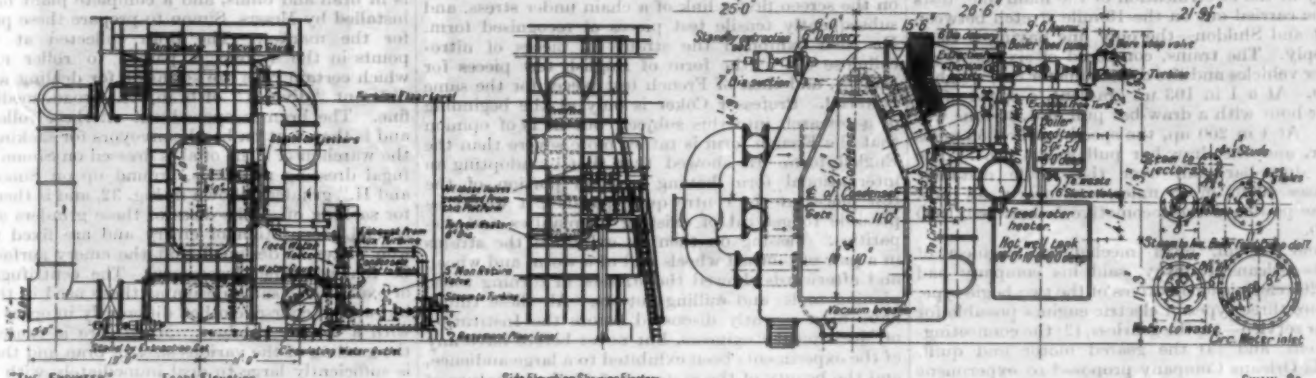



FIG. 227—FRONT AND SIDE ELEVATIONS AND PLAN OF CONDENSER FITTED WITH DELAS AIR EXTRACTORS

contains about 31 miles of tubes. The principal dimensions, weights, &c., are as follows:—

| | |
|---|---|
| Area of cooling surface | 46,000 sq. ft. |
| Water circulating through the tubes | Once (and, if required, twice) |
| Quantity of circulating water required, gallons per hour | 2,400,000 |
| Overall size of shell, including the top and bottom circulating water boxes— | |
| From back to front | 28ft. |
| Height | 34ft. |
| From side to side | 11ft. |
| Overall size of plant, including exhaust connections and pipe work— | |
| From back to front | 58ft. |
| Height | 35ft. 6in. |
| From side to side | 46ft. |
| Dimensions of exhaust opening— | |
| Height | 12ft. |
| Width | 6ft. |
| Circulating water outlet, diameter | 42in. |
| Weight of condenser with pipe work, tube plates, tubes, pumps, &c., approximately | 220 tons |
| Weight of tubes and tube plates | 60 tons |

In order to avoid the necessity for deep foundations the exhaust inlet has been placed on one of the sides of the condenser, and the connection to the turbine exhaust outlet is made with a curved adapting pipe and with a copper expansion pipe immediately below the turbine exhaust. The turbine and condenser are placed side by side and the top of the circulating water inlet box is at approximately the same level as the top of the turbine. At the top of the condenser there is a deep open box having three connections on one side for the circulating water inlet and outlets and weir, with a grid box on the other side for an overflow pipe.

In this box gates or dividing plates are fitted to enable the circulating water to make two passes through the tubes instead of one. For single flow working these gates may be raised by means of special gear, which is operated from a platform surrounding the top of the condenser. The central portion of the condenser which forms the actual condensing chamber has the exhaust steam inlet at one end and the air outlet branches at the other end. One of these branches is at the top and the other below the centre division of this chamber, and a third branch is provided at the bottom for connecting the condenser to the extraction pump.

The makers direct particular attention to the special system of staying. There are forty-eight lateral stays, 1¼in. in diameter, and each stay is contained in a cast iron tube, which fits between the two sides of the condenser. Four cross girders arranged laterally also act as stays to the condenser shell and support the tube plates at the top and bottom. Besides the lateral stays there are vertical stays, which tie the top and bottom tube plates together. The supporting plate in the centre is also secured to these stays by means of collars. Both the tube plates are composed of brass, the top one being $^{13}/_{16}$in. thick and the bottom one $1^{3}/_{16}$in. thick. Each plate is built up of six sections and above the top plate a guard plate 1¼in. thick is fitted to deal with leaves, &c., in the circulating water. The tubes, which have an internal diameter of 1in., are composed of solid brass 18 S.W.G. thick, and are expanded into the top plate and fastened in the bottom plate by screwed ferrules which are made tight with cotton tape packings.

The base of the condenser forms a water box and settling chamber, and a branch is provided at one side for use when it is desired to work the condenser on the two-flow principle. At one end circulating water outlet branches are provided and a branch pipe for flushing out sludge and dirt.

The air is extracted by three Cole, Marchent and Morley Delas air extractors. Two of these extractors will, however, deal with the whole of the air, the third serving as a spare. They are arranged at the end of the condenser opposite the exhaust branch and a special platform is provided so that the turbine driver can easily reach them. It will be remembered that one of the special features claimed for the Delas steam jet air extractors is that about 85 per cent. of the heat in the steam operating the jets is recovered by heating the boiler feed water. In the case of the plant under consideration the auxiliary turbine exhaust steam and the steam from the Delas extractors pass through a feed-water heater of the surface type.

The condenser is fitted with two multi-impeller centrifugal extraction pumps. A multi-stage rotary boiler feed pump is driven by an auxiliary turbine which develops 102 horse-power at 2500 revolutions per minute, and there is also an electrically driven boiler feed pump of the same type. The main feed tank or hotwell measures approximately 10ft. by 10ft. by 6ft. and the boiler feed supply tank 6ft. by 5ft. by 6ft. Both tanks are built of cast iron plates.

For use in connection with these water tanks there is a 6in. Venturi meter provided with integrating and recording mechanism and having a range of from 3000 to 25,000 gallons per hour. By-pass valves enable the meter to be isolated if necessary. The circulating water is pumped from the river Aire through a 42in. inlet pipe up to the top box of the condenser, and after passing through the tubes it flows into the lower box and back into the river by gravity.

## Institution of Mechanical Engineers.

### SUMMER MEETING IN PARIS AND LIEGE.

No. I.

A LARGE party of members of the Institution of Mechanical Engineers and some ladies left Victoria at mid-day on Monday, June 12th, with Amiens as their immediate destination. There they arrived soon after 8 p.m., and devoted the following morning to an inspection of the magnificent cathedral and other places of interest in the ancient city. After luncheon, the whole party left in a train of motor cars to drive through the devastated regions to Compiègne, distant, by the route followed, about 66 miles. The members could not but be impressed by the destruction of buildings wrought by the war and by the shell-scarred trees, but the traces of the war are rapidly disappearing. Few trenches were seen, and there was but little of the *débris* of the battlefield. Between Chuignolles and Chuignes a halt was made to allow of the inspection of a long-range gun erected by the Germans and captured by the Australian troops. Unfortunately, precise information about the gun was not available, but as far as could be learnt it fired no more than six shots at Amiens, some twelve or fourteen miles distant, before the Germans themselves blew it up when they were forced to retire. Its bore is about 15in. and the total length may have been 80ft., but a large piece had been cut away from the muzzle, and the breech end was blown to pieces. It was difficult to say what the actual mounting was like, but it was apparently something between a garrison and naval design, with fixed position loading. The roller path covers only about half a circle, and is so placed that the piece might have ranged on Amiens and St. Just, but not on Compiègne and possibly not on Paris. It is not probable in any case that the gun would have carried the 70 odd miles to the capital.

After dinner at Compiègne, the party entrained for Paris, which was reached at about 10.45.

On Tuesday morning the members met at the building of the Ingénieurs Civils in the Rue Blanche, where they were welcomed by the President, Monsieur Laubeuf, and by Professor Guillet. Dr. Hele-Shaw acknowledged the welcome, and assured the French engineers of the cordial friendship of British engineers. The minutes of the last meeting were then taken as read, and the President then announced that, in view of the shortness of time, it would be impossible to listen to long discussions of the papers, but that the opinion of the Council was that some of them merited much fuller debate than could then be given, and he hoped that an opportunity would be found for dealing with them in London. He then called upon Monsieur Sauvage to read his paper on "Feed-water Heating on Locomotives." The author, in excellent English, presented a brief epitome of his essay. The paper is for the greater part a description of familiar systems, and we give only the latter portion of it.

#### FEED-WATER HEATERS FOR LOCOMOTIVES.

A fair comparison of the different systems of heaters would require a knowledge of initial cost and expenses of upkeep in regard to the economy of fuel. But there are at present difficulties in collecting exact figures on these points, as may be judged from the conclusions in the report of Mr. Laroin to the International Railway Congress at Rome:—"Although certain railways have applied apparatus of that kind to a large extent, and it seems the time is coming for their general use, the trials do not permit, as yet, of sufficiently precise comparisons of the different systems being drawn. Early conclusion of these trials would be of great utility in assisting the rapid general adoption of feed-water heaters."

It may be added that available data as a rule show a decided economy of fuel due to the use of feed-water heaters; in some cases exceeding the average 10 per cent., which corresponds to the quantity of heat recuperated. This result may be due to some indirect advantages of the system.

In conclusion, the question of feed-water heaters for locomotives may be summarised as follows:—

(1) Feed-water heating with exhaust steam gives an economy of fuel or an increase of power, or both together. The results of practice correspond with the theoretical predictions on this point.

(2) The use of steam pumps is convenient for fine regulation of a continuous feed, at least during prolonged runs without stops.

(3) Tapping out part of the steam for heating is without a marked influence on the draught, as this allows a supplementary production of an equivalent quantity of steam.

(4) Apparatus that return the condensed steam to the boiler reduce the consumption of water and allow a longer mileage after each wash out.

(5) On the other hand, deleterious effects from oily matter in the boiler might be expected; however, no trouble from this cause appears to have been reported.

(6) Appliances that eliminate the gases in solution in the water are to be recommended, as retarding the pitting and grooving of the plates. Measurements of the proportion of gases eliminated is desirable.

(7) With each apparatus it is interesting to know what proportion of the heat received by the water is due to the exhaust of the engine apart from the exhaust of the pump.

(8) Facilities for removing the scale from the heater are absolutely necessary.

The discussion on this paper was opened by Sir Vincent Raven, who expressed his agreement with the author that there was insufficient space on a locomotive to utilise the waste heat in the smoke-box. He laid stress upon the fact that exhaust steam was only available when the engine was running, and that as a consequence during much of the working time of the engine feed heating could not be carried on. On the whole, he thought an exhaust injector was the most convenient form of feed heater, but he found it desirable to employ a combination injector. One of the difficulties was the human element, for it was impossible to make sure that the drivers used the exhaust injectors when the engines were running. Oil separation was also another important matter, and it was essential that the filter should be carefully attended to. He had found an economy of about 5 per cent. either with exhaust injectors—Davis and Metcalfe—or the Weir system.

Monsieur Herdner also laid stress upon the danger of oil passing into the feed, and said that he expected 10 per cent. economy.

Mr. Pulman gave some particulars of the operation of the Worthington open-type heater. He mentioned

that in some cases 12 to 15 per cent. of the condensate had been returned to the feed.

Major Cowan, after referring to his work done with Mr. Trevithick on the Egyptian State Railways, and their paper read before the Institution in 1913, said that he believed there was a future before feed heating on locomotives, and he mentioned that 8 per cent. economy had been secured by feed heating on the Great Western Railway. Mr. Sauvage deferred his reply till the written discussion was before him.

A formal vote of thanks to the author having been passed by acclamation, the President called upon Sir Vincent Raven to present his paper. It was, he said, a paper which he hoped to hear discussed at a joint meeting with the Institution of Electrical Engineers. We began to reprint it in full in our last issue and finish it to-day.

In presenting it, Sir Vincent Raven added some particulars as to tests made with his latest 4–6–4 electric locomotive. He premised them by observing that as far as he knew there was no other electric locomotive in existence capable of running at steam engine speeds, but his new engine was designed for speeds between 25 and 90 miles per hour. Owing to the delay in the electrification of the main line, tests had to be carried out on the 18-mile stretch between Newport and Shildon—the only line having a 1500-volt supply. The trains, composed of sixteen bogie passenger vehicles and the dynamometer car, weighed 463 tons. At a 1 in 103 up gradient, a speed of 42 miles per hour with a draw-bar pull of 6.66 tons was secured. At 1 in 200 up, the speed reached 58 miles per hour, and the draw-bar pull was 4 tons. The average draw-bar pull over the whole distance, which rises 400ft. in 18 miles, was nearly 5½ tons. The horse-power of the locomotive is between 1800 and 2000.

Monsieur Lacoin, chief mechanical engineer of the Paris–Orleans Railway, said his company had ordered 200 electric locomotives of the two-bogie type. There were three types of electric engines possible for passenger service—(1) the gearless, (2) the connecting-rod system, and (3) the geared motor and quill. The Paris-Orleans Company proposed to experiment with the first two types, relying upon Sir Vincent Raven's experiments for the third. The current was direct and the voltage 1500. The horse-power of the locomotives would be between 3000 and 3500.

Mr. Pendred said that an impression had gained ground that Sir Vincent Raven was an out-and-out electric locomotive man, and that he thought the steam locomotive had lived its day. He was happy to say he was in a position to correct that error. Sir Vincent still believed in the steam locomotive for certain duties, and he was actually completing a very large three-cylinder engine. Mr. Pendred hoped that in due course the results of comparative tests between the electric and steam locomotives would be available.

Sir Vincent Raven, in his reply, answering a question raised by Monsieur Lacoin, said that he had placed the buffers on the bogies on one of his electric goods locomotives, because the buffing of loose coupled goods trains was very severe, and he thought the bogie gave better buffing support than the body. He assured Monsieur Lacoin that the results of his experiments would be gladly given to the Paris–Orleans, whose engineers would be very welcome at the tests. Monsieur Lacoin replied that he would be very glad to see the North-Eastern Railway represented at the French trials. In reply to a question raised by Professor Lea, Sir Vincent stated that the centre of gravity of his latest electric locomotive, with 6ft. 8in. coupled wheels, was nearly as high as in his latest steam locomotives. He thanked Mr. Pendred for giving him the opportunity to say that he believed the steam locomotive had possibilities of further development, and he hoped in the not distant future to see the same trains hauled as far as Newcastle by electric engines, and thence further North by steam engines. Comparative costs of the two systems would be ascertained.

A short paper on "Mechanical Vehicles and Road Surfaces," from which we extract a small portion, was then read by the secretary, in the unavoidable absence of the author, Lord Montagu of Beaulieu.

### Mechanical Vehicles and Road Surfaces.

It must be borne in mind that the problem of making roads strong enough to withstand the increasing strains, to which allusion has been made, is to-day one of finance, and only in a secondary degree one of engineering. Most competent modern road surveyors and engineers, if given sufficient money, can make a road strong enough to stand almost any strains and its use by vehicles at almost any speed. But to make such a road is very costly, and the expense increases rapidly if heavy weights at high speeds have to be provided for. Already roads specially surfaced cost as much as 15s. or even more per superficial yard in the case of main trunk roads through country districts, and as much as 30s. to 40s. per superficial yard in the case of much-used streets in towns, which are paved with stone setts, wood blocks or asphalt laid upon concrete foundations. It is clear that in over-taxed and over-rated Europe such a cost cannot continue to be provided, except in special cases where the heaviest and most constant traffic exists, and if only these expensive surfaces last for a really considerable period of years during which no repairs of any consequence are necessary. A cheaper form of road-making is therefore very desirable if we are to continue to improve our highways in strength and smoothness and road traffic is to be worked economically. Any highway engineer or highway construction firm who can lay down a road in the neighbourhood of, say, 5s. per superficial yard for the ordinary main trunk road, will deserve the thanks of all motor vehicle users, as well as of the suffering tax and rate payers. The author is inclined to think that most of the present system of roadmaking by what is known as single or double carpet work on specially prepared foundations is too expensive for our present impoverished state. Economy as well as efficiency will, it is hoped, be secured eventually by some other cheaper process.

Improvements in the methods of roadmaking and in the diminution of cost are of immense present and future interest to the users of mechanical vehicles, for Governments and local authorities are finding it increasingly difficult to obtain money to spend on road improvement and maintenance. It is, at the same time, incumbent on designers and makers of mechanical road vehicles to spread the weight of their vehicles over more wheels if possible, and to limit the total weight borne on each wheel to more reasonable amounts, say, 2½ tons as a maximum.

A brief discussion, in which Lieut.-Colonel Hutchinson and Mr. Paichell took part, brought the morning's meeting to an end.

After luncheon, visits were paid by groups of members to the works of Messrs. Hotchkiss and Co., and the French Thomson-Houston Company, to those of Messrs. Renault, and to the Conservatoire National des Arts et Métiers.

On Wednesday evening, Professor Coker delivered a lecture on his optical system of measuring strain by polarised light. The most attractive portion of this lecture was that devoted to the exhibition on the screen of the actual effects obtained by this elegant method. For this purpose, Professor Coker brought to Paris his lantern lenses and Nicols, and he showed on the screen first a link of a chain under stress, and subsequently tensile test pieces of recognised form. He then exhibited the strains in pieces of nitro-cellulose cut in the form of English test pieces for cement, and then of French test pieces for the same material. Professor Coker is only at the beginning of a research into this subject, but he is of opinion that the French form is rather more severe than the English form. He showed then that by adopting an international form having a small portion of the test pieces at the centre quite parallel, it would be possible to get rid of existing inequalities and disparities. Passing on then he exhibited the strains in a pair of toothed wheels and of a worm and wheel, and afterwards showed the stresses in turning tools, planing tools, and milling cutters. All these things have been recently discussed before the Institution of Mechanical Engineers, but never before have any of the experiments been exhibited to a large audience, and the beauty of the system and the lucid nature of the colour figures produced led to loud applause from the members and French visitors. Every experiment passed off without a hitch of any kind, even including an unrehearsed experiment, when a tensile test piece was intentionally broken. Professor Coker and his assistants are to be heartily congratulated on a very great success.

On Thursday morning the meetings were resumed at the house of the Société des Ingénieurs Civils, but the attendance was so small that it was determined to take some of the papers again at a London meeting in the autumn. The first paper presented was that by Professor Auguste Rateau, of which the following is an abstract :—

### The Use of the Turbo-compressor for Attaining the Greatest Possible Speeds in Aviation.

The author examines the relations between specific pressures and densities at different altitudes, and shows that when flight can be performed at great heights, it will be possible to attain speeds as great as 250 miles per hour. He shows that the aeroplane is the only vehicle in which the power required for movement is independent of the speed. The present speed of 150 miles per hour is insufficient to give a real commercial advantage over railway transport, but by flying at a height of 7 miles, in the stratosphere, the higher speed can be attained, which means raising the ceiling. At this height the temperature is — 54 deg. Cent., and the living conditions for the pilot and passengers or crew become difficult; but there is prospect of obtaining an air-tight engine-room and cabin that can be raised to a pressure nearly equal to the normal atmospheric pressure.

The main difficulty in the way of the solution of the problem of flight at great heights has been that of introducing a full charge of air into the engine. Examination of the diagrams shows that there is a rejection of about 60 horse-power in the exhaust of a normal 250 horse-power engine. The efficiency of an exhaust turbine can be over 50 per cent., and of a turbo-compressor over 50 per cent., giving an overall efficiency of 25 per cent., which is sufficient for the purpose.

The author considers other methods of obtaining this supercharging by a power-driven compressor, and shows the disadvantages of such a system and its limitations.

He concludes that flight should be possible at a speed of 250 miles per hour with war or sport machines flying at an altitude of 5 kiloms. or 6 kiloms., and that to obtain still greater speeds further progress is necessary in lightening the aeroplane, further reducing the fineness of the machine, producing a variable pitch propeller and constructing an air-tight chamber for the engine and crew or passengers. With such a machine, flight from Paris to Tokio would take only three days of eight stages in all.

A machine fitted with a Rateau turbo-compressor has flown to a height of 9 kiloms. with a passenger—the record—in France, and a solo flight with a supercharged machine of 12 kiloms. has been made in America.

The author did not read his contribution, but gave an outline of its main features in a short discourse. He was followed by Mr. Reavell, who also gave an outline of his paper on "Air Compressors," of which the following is an abstract :—

### Air Compressors.

The paper deals with the salient features which must be observed in the various air compressors in order to ensure that efficient results in operation are secured.

It treats first of the construction of compressor cylinders for machines of the reciprocating type, both single and double acting, and the illustrations in this part of the paper show types of valves as well as arrangements for cylinder and cylinder cover cooling.

The effect of clearance volume in single and multi-stage compressors is discussed, and also the question of mechanical efficiency.

The paper also treats of the effect upon the index of compression which obtains from variations in the diameter of the cylinders, in the piston speed, the question of single or double-acting construction, and other factors which affect the matter; and the arguments put forward are supported by indicator diagrams.

After dealing with other important features in connection with reciprocating machines, the author deals with the question of rotary compressors of various types, leading up to the modern turbo-compressor. In connection with turbo-compressors, the improvements in design which have been introduced since the early days of turbo-compressor construction are dealt with and explained, and particulars are given of the performance which can be expected at modern peripheral speeds from turbo-compressors to-day.

The effect of cooling in turbo-construction is investigated, and the importance of independent intercoolers in place of cooling the casings only; diagrams illustrating these points are given.

These two papers were taken together, but it was decided to defer discussion of them till a full meeting could be arranged when we shall have an opportunity of dealing with them at greater length.

## A Modern Flour Mill.

No. IV.*

### Plants for Dealing with Bran and Offals.

An important branch of Messrs. Vernon's business is in bran and offals, and a complete plant has been installed by Messrs. Simon to prepare these products for the market. The bran collected at various points in the system is passed to roller mills in which certain rolls are set aside for dealing with the different "divides" of bran, i.e., broad, medium, or fine. The bran is opened out on these roller mills and is then sent on band conveyors for sacking off in the warehouse. The offal is dressed on Simon centrifugal dressing machines, ground up on Simon "H. and H." grinders, shown in Fig. 32, and is then ready for sacking off. The discs of these grinders are of a special preparation of emery and are fixed to cast iron plates so designed that the emery surfaces can be renewed when necessary. The centrifugals are of exactly the same design as those used in the mill, but are, of course, clothed differently in order to deal with a coarser product. Much care is exercised in the grading of the various sizes of bran and the plant is sufficiently large to deal immediately with all the bran and offals passed to it from both the mill and the wheat cleaning

### Dust Collection.

As will have been gathered from a perusal of the foregoing description of this mill, air currents play a very important part in the wheat cleaning and milling processes. Not only are strong aspirations employed to remove impurities, but also to exhaust the humid air from roller-mills and other machines in the mill. A certain amount of heat is generated, particularly in the breaking down and grinding processes, and the stock is cooled by drawing through it a steady stream of cold air. It is necessary, however, to provide a safe and efficient method of collecting and filtering the air exhausted from all machines, as naturally such air carries, in suspenaion, dust and other impurities, which would be dangerous as well as unpleasant if allowed to escape into the atmosphere. The machines used for separating the dust from the air are suction filter dust collectors and cyclone dust collectors, the former being in the mill and the latter in the wheat-cleaning department, and so efficiently do these machines perform their work that the air on the various floors is absolutely free from dust.

The suction filter dust collector—Fig. 34—consists of a wooden frame divided into a number of compartments in which are groups of textile sleeves specially woven for this purpose. The dust-laden air is drawn up from a chamber at the bottom of the machine into the sleeves which retain the dust, but allow the purified air to escape through the texture and thence to the fan. An automatic cleaning arrangement is provided in order to clear the dust from the inside of the sleeves, and this is so thorough that a cloth of very close mixture can be used without the sleeves becoming choked. By means of mechanically operated timing mechanism the dust-laden air is shut off from each group of sleeves in turn and a small quantity of pure air is drawn through them in the reverse direction. At the same time, by means of a cam, this group of sleeves is shaken vigorously several times, with the result that the dust which has collected is shaken free of the inside of the sleeves and falls into the hoppered chamber below, and is carried away by a worm conveyor through an air seal. Only one section of sleeves is cleaned at a time, so that there is always a sufficient number of sleeves in action to ensure thorough filtration of the air. The cyclone dust collector employed is one of the oldest types of dust separator. It deals effectively with air carrying heavy impurities and is particularly useful in the wheat cleaning side of the mill, owing to the fact that it is built entirely of sheet metal and is consequently fireproof. In principle the apparatus depends upon the fact that in a whirling current of air the dust particles, being slightly heavier than the air, tend to fly to the outside of the circle in which the air moves. The upper part of the cyclone consists of a short cylinder, while the lower part is a cone. The dust-laden air is blown into the cylindrical part tangentially at the top, setting up a cyclonic action which throws the dust particles to the sides of the cone, against which they impinge, and then settle down to the bottom, where they are sacked off.

* No. III. appeared June 16th.

The air passes away through a tube in the centre of the top of the cyclone and thence to a cowl on the mill roof.

### BULK STORAGE OF FLOUR.

The final storing and sacking off of the finished products is particularly interesting, in that Messrs. Vernon have adopted a method which is a complete revolution of the system in vogue in practically all other mills in this country. It is the general practice for millers to sack off all flour and offal and other mill products as fast as they are made; consequently in mills running night and day this means that the packing, weighing, trucking and storing of the bags has to be carried on continuously for twenty-four hours a day. Messrs. Vernon, however, deal with their finished products in quite another way. Bins have been installed in which the finished products are stored in bulk, sufficient bin accommodation being provided to store all the flour produced during a twenty-four hour run. By this means night packing is avoided and the products made during the twenty-four hours can be dealt with in one eight-hour day shift. A number of separate bins, shown in Fig. 35, page 696, are provided for each grade of flour, and the feeding arrangements are such that the various products can be distributed to any of the bins as required. The various grades of flour coming from the mill are weighed on "Avery" automatic flour weighers, and then redressed on centrifugals before being sent to the bins. The bins are fed automatically by means of conveyors running continuously with the mill.

As flour is not a free running material like wheat, an important feature in the bulk storage of this commodity is the discharging mechanism for emptying the bins. The chief difficulty to contend with is the tendency of the flour to "arch" or hold up, after a certain quantity has been drawn from the hopper outlet, such arching being followed by a sudden collapse of the material remaining in the upper portion of the bin. These sudden displacements may possibly result in damage to the bin walls and hopper bottom or the bin discharging appliance. Messrs. Simon claim, however, to have succeeded in over-

FIG. 31—POWER HOUSE AT THE MILLENNIUM FLOUR MILLS

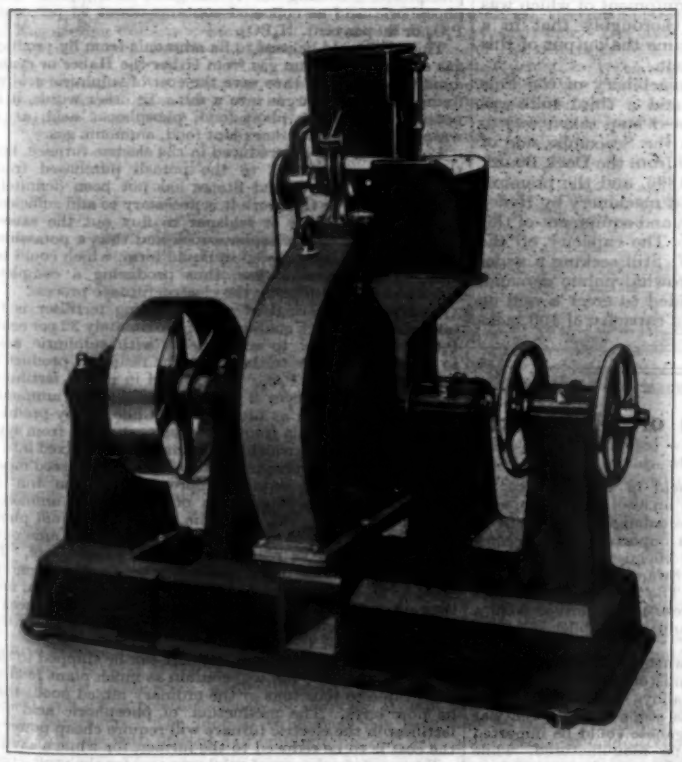


FIG. 32—GRINDING AND SHELLING MILL

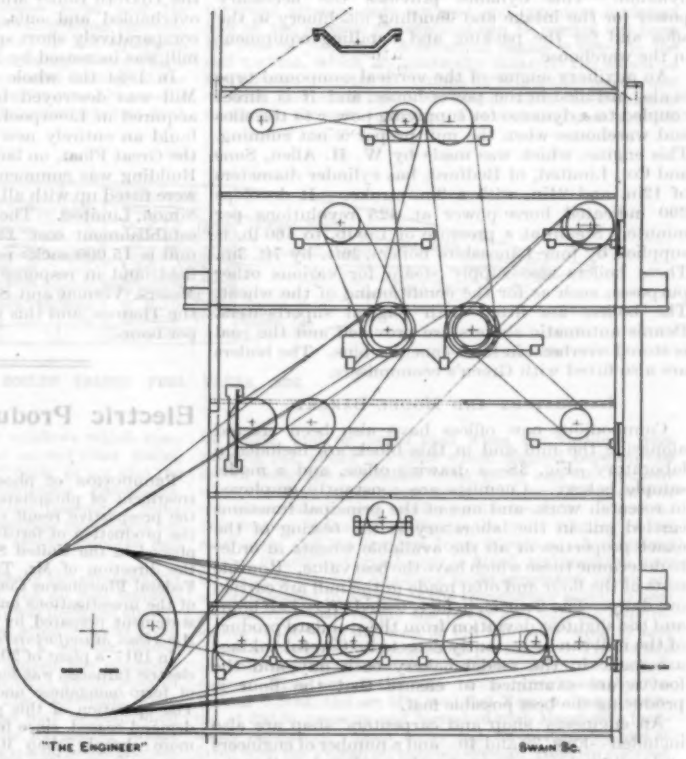



FIG. 33—SECTION THROUGH ROPE RACE

coming this difficulty, and have produced a bin discharging mechanism—Fig. 36—whereby the material is evenly discharged throughout the entire run from full to empty bin. The products drawn from the hoppers are sacked off on a row of mechanical packers, to which are fixed "Richard Simon" automatic flour scales—Fig. 37. These packers are placed on a lower floor, and after packing the sacks are trucked away for sewing up and are then either stored in the warehouse or delivered by shoots to boats, railway wagons or lorries, for despatch to the customer. The bins were erected by Messrs. Vernon, and the necessary feeding and discharging appliances were supplied by Henry Simon, Limited.

### Power Plant.

The whole of the power for the plant, with the exception of the pneumatic intake plant and the machine shops, is supplied by means of a horizontal compound surface condensing engine, shown Fig. 31, built by Messrs. Carels Frères, Belgium, and developing 1200 horse-power. The cylinders are 53½in. by 33½in. diameter by 4ft. 7½in. stroke, and the fly-wheel diameter is 22ft. The power is transmitted through the medium of thirty-six cotton ropes taken direct off the fly-wheel—Fig. 33. The power to the milling and wheat-cleaning plants is supplied direct, whilst that for the silos and warehouse is supplied through a dynamo. This dynamo provides the necessary power for the intake and handling machinery in the silos and for the packing and handling equipment in the warehouse.

An auxiliary engine of the vertical compound type is also installed in the power-house, and it is direct coupled to a dynamo for supplying power to the silos and warehouse when the mill proper is not running. This engine, which was made by W. H. Allen, Sons and Co., Limited, of Bedford, has cylinder diameters of 12in. and 21in. with a 9in. stroke. It develops 290 indicated horse-power at 425 revolutions per minute. Steam at a pressure of 150 lb. to 160 lb. is supplied by four Lancashire boilers, 26ft. by 7ft. 3in. These boilers also supply steam for various other purposes, such as for the conditioning of the wheat. The boilers are fitted with Sugden superheaters. Bennis automatic stokers are provided and the coal is stored overhead in ferro-concrete bins. The boilers are also fitted with Green's economisers.

### Laboratory and Model Bakery.

Commodious new offices have also been erected alongside the mill and in this block are included a laboratory—Fig. 38—a drawing-office, and a model sample bakery. Chemists are constantly employed in research work, and one of the principal functions carried out in the laboratory is the testing of the exact properties of all the available wheats in order to determine those which have the best value. Routine tests of the flour and offal made in the mill are carried out daily. The flour is, in fact, tested every half hour, and the slightest deviation from the standard product of the mill can be instantly detected. Careful bakings are made in the model bakery each day, and the loaves are examined to ensure that the flour is producing the best possible loaf.

An engineers' shop and carpenters' shop are also included—Figs. 39 and 40—and a number of engineers and millwrights are permanently employed, so that the machinery throughout the mill is maintained at a high state of efficiency. Repairs to the large fleet of road wagons are also carried out in the shop, which is laid out on modern lines and equipped with up-to-date machine tools.

As a conclusion of this series of articles on what is really a fine specimen of a modern flour mill, a short reference to the history and growth of the firm which owns it may not be out of place. The founder of the firm, William Vernon, started corn milling in Staffordshire in 1796. Twenty-seven years later, his son, John, succeeded to the business, which he carried on in the same place up to the year 1847, when he displayed some of the enterprise which has been characteristic of the firm, by becoming the owner of the Fole Mill, situate on the river Tean, a tributary of the Mole, and about four miles from Uttoxeter. In 1857 Mr. John Vernon gave place to his son, William, who introduced, in 1879, porcelain rolls to the mills. So energetically did he reform the methods, that in five years he had discarded the water wheel for an engine, and replaced the whole of the original plant and machinery with a complete installation of the Luther system, with rollers by Ganz, of Budapest. At this time, Mr. William had the help of his two sons, Mr. J. Herbert and Mr. William A. Vernon, who became partners with their father in the years 1882 and 1885 respectively. When the firm found that 75 per cent. of the grain they milled had to be brought to Fole from Liverpool, they examined the possibilities of extending and establishing their business in Liverpool. In 1888 they secured a roller mill in Commercial-road, Liverpool. Further development occurred in the year 1891, when the firm purchased the Toxteth Roller Mills, the equipment of which was overhauled and enlarged so thoroughly that in a comparatively short space of time the output of this mill was increased by 25 per cent.

In 1894 the whole of the machinery of the Fole Mill was destroyed by fire, and a third mill was acquired in Liverpool. The next step taken was to build an entirely new mill on the Seacombe side of the Great Float, on land leased from the Dock Board. Building was commenced in 1896, and the premises were fitted up with all the latest machinery by Henry Simon, Limited. The erection and equipment of this establishment cost £200,000. The capacity of the mill is 15,000 sacks per week. Still seeking a wider field, and in response to a growing public demand, Messrs. Vernon and Sons decided to erect a mill on the Thames, and this mill has a capacity of 100 sacks per hour.

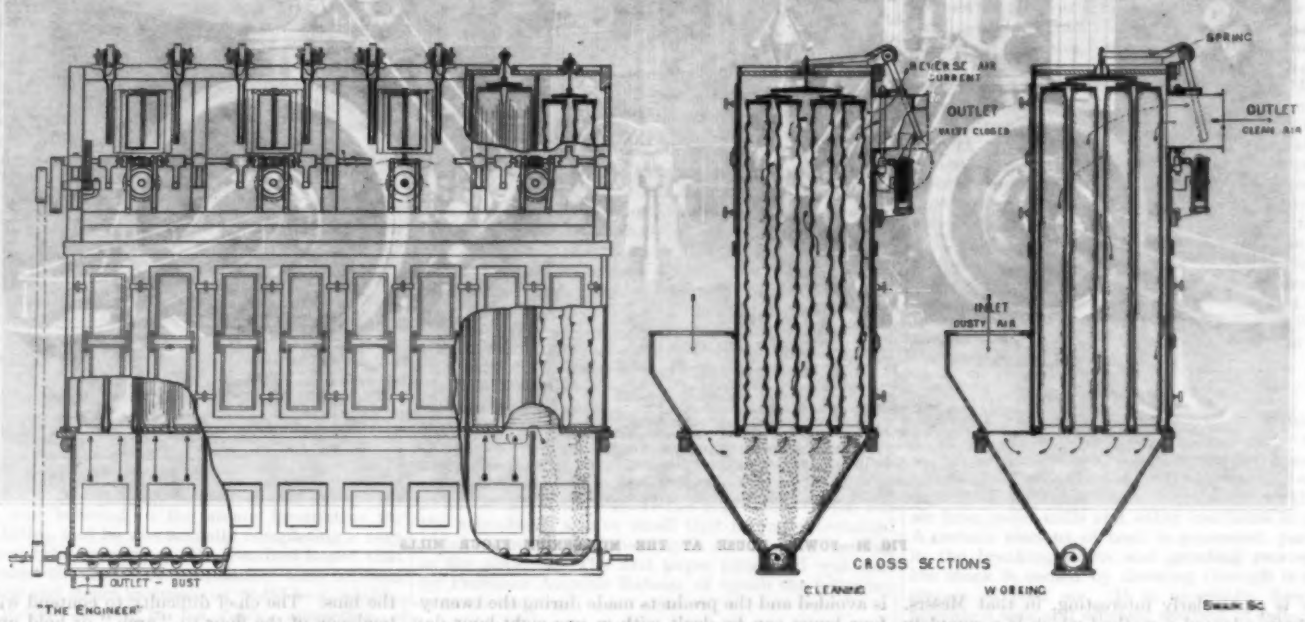



FIG. 34—SUCTION FILTER DUST COLLECTOR

## Electric Production of Phosphoric Acid.

Production of phosphoric acid of high quality by treatment of phosphate rock in an electric furnace, with the prospective result of great economic development in the production of fertiliser, is an important work accomplished in the United States by chemists working under the direction of Mr. Theodore Swann, president of the Federal Phosphorus Company. The following particulars of the investigations and their results are derived from a statement prepared by Mr. Swann and published in the *American Manufacturers' Record*.

In 1917 a plant of 20,000 kilowatts capacity, with eight electric furnaces, was built at Anniston for the production of ferro-manganese and other alloys for war purposes. The operation of this plant was stopped when the war demand ceased, since ferro-manganese could be imported more cheaply than it could be manufactured, while manganiferrous iron could be made more cheaply in blast-furnaces. In 1918, at the suggestion of the War Industries Board, experimental work was begun for the production of potash—of which the supply was short—and also for the production of elemental phosphorus for smoke-screen work in military activities. By the summer of 1921 this process had been put on a commercial basis.

Although phosphoric acid is employed principally in the fertiliser industry there are many uses for it in food products, these latter uses including four general classes:—(1) The liquid phosphoric acid; (2) the calcium group, in which the acid is mixed with lime to form mono-calcium, di-calcium and tri-calcium phosphate; (3) the sodium group, in which the acid is mixed with soda ash or caustic soda to form mono-sodium, di-sodium and tri-sodium phosphate; (4) the ammonia group, in which the acid is mixed with ammonia to form mono-ammonium and di-ammonium phosphate. To meet the Pure Food Law a very pure acid is required, and this is obtained from phosphate rock and bone treated chemically to remove impurities.

The electric furnace process was developed with the primary idea of producing high-grade phosphoric acid, as this method lends itself readily to the elimination of many of the impurities. The process consists of charging phosphate rock into an electric furnace, with coke breeze to supply the carbon necessary as a reducing agent, silica rock to flux out the excess lime present in the phosphate rock, and iron turnings to form ferro-phosphorus, an alloy used in the steel industry.

The production of ferro-phosphorus serves to remove largely the iron from the acid, which would be present and difficult to remove if the rock was treated with sulphuric acid, as in the old process. The phosphorus evolved by the heat of the electric furnace when coming in contact with air above the stock or charge in an enclosed furnace burns to phosphorus pentoxide, a condensed, heavy white fume that is carried over in the gases. Being hydroscopic, when cooled to certain temperatures a portion of it condenses and the remainder is collected by the electric precipitators, coming out of the gases as a liquid. The phosphoric acid as collected contains about 65 per cent. $P_2O_5$ or 90 per cent. $H_3PO_4$.

This acid could be used to fix ammonia from by-product gas or the ammonium gas from either the Haber or cyanamid processes and thus save the cost of sulphuric acid in fixing the ammonia gas into a salt. In other words, it is possible to use one plant food, phosphoric acid, as a wrapper to tie up another plant food, ammonia gas.

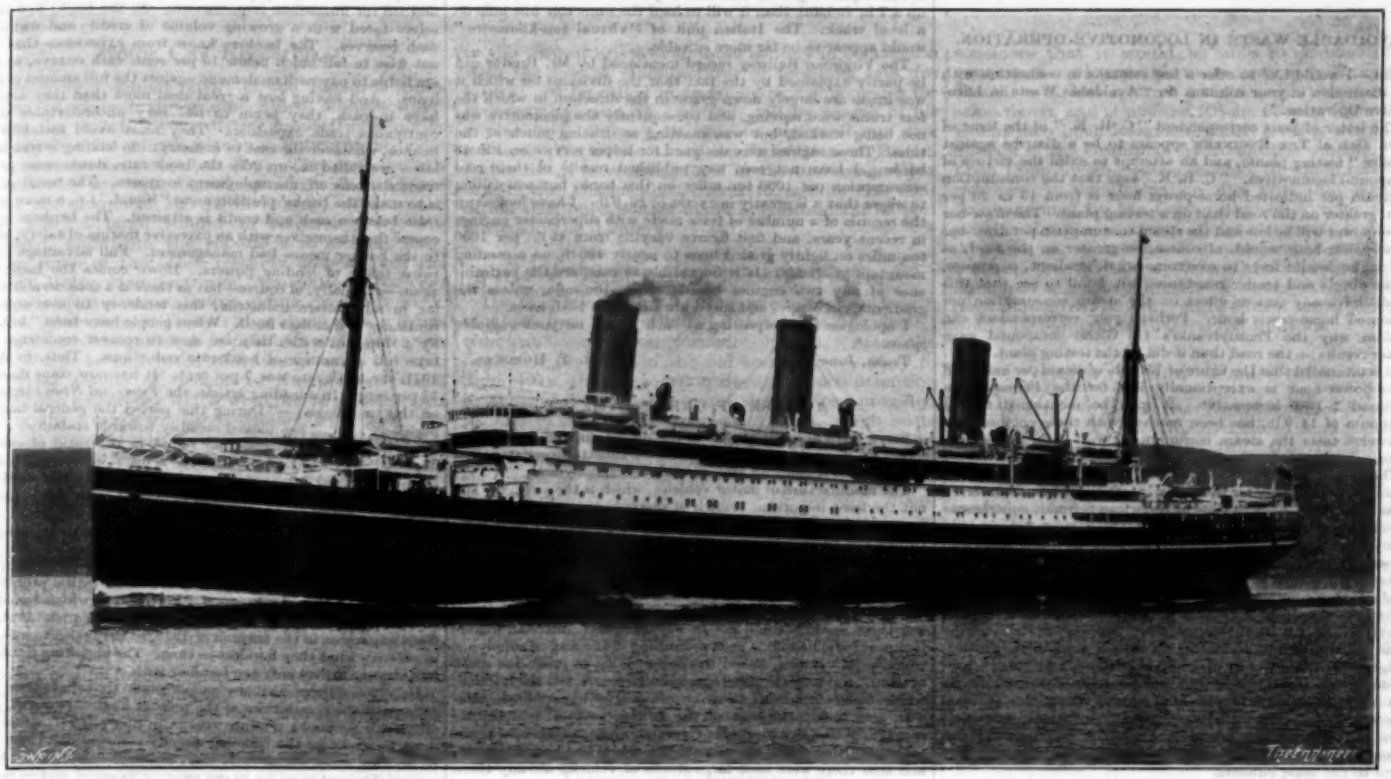
Potash can also be produced in the electric furnace, but the cost as compared to the potash purchased from abroad or in the United States has not been definitely established. For this work it is necessary to add sufficient potash-bearing shale or feldspar to flux out the excess lime present in the phosphate rock and thus a potassium phosphate can be collected in liquid form, which could be used to fix ammonia gas, thus producing a complete concentrated fertiliser by the electric furnace process.

The present method of manufacturing fertiliser is to take phosphate rock containing approximately 32 per cent. $P_2O_5$ grind it, and to acidulate it with sulphuric acid to make it available to the soil. The resultant product is about 16 per cent. $P_2O_5$. When used in mixed fertiliser, the average is not over 9 per cent. $P_2O_5$. The ammonia content is obtained as nitrate from Chile, as by-product sulphate of ammonia from the coke ovens, and from synthetic processes, in which the ammonia gas is fixed into a salt by use of sulphuric acid; also from cotton seed meal, tankage, &c. It requires approximately one ton of sulphuric acid to produce a ton of sulphate of ammonia containing 25 per cent. ammonia. By using liquid phosphoric acid produced in the electric furnace, this ammonia gas can be fixed as readily as with sulphuric acid. In other words, taking one element of plant food, phosphoric acid, to fix another element of plant food, ammonia, and then mixing with it the third element, potash, produces a complete concentrated fertiliser of four to five times the concentration of the present fertiliser.

This concentrated mixed fertiliser can be shipped to the farmer, so that one ton will contain as much plant food as from three to four tons of the ordinary mixed goods that he now buys. The production of phosphoric acid for fertiliser in the electric furnace will require cheap power if the cost is to be reduced to the farmer, for while a saving will be made in the use of sulphuric acid for the production of acid phosphate and in the freights, as an offset against this there will be the cost of power for smelting the phosphate rock in the electric furnace.

Three electric furnaces with an aggregate capacity of 12,000 horse-power are now being operated by the Federal Phosphorus Company for the production on a commercial basis of ferro-phosphorus and high-quality phosphoric acid for food purposes. Fertiliser has been produced in

# THE CANADIAN-PACIFIC LINER EMPRESS OF AUSTRALIA



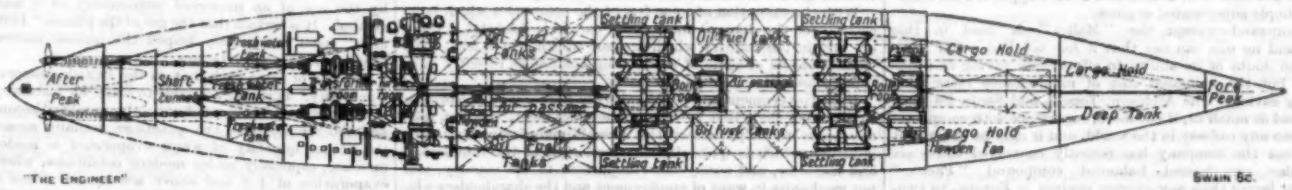
small quantities, developing the process and demonstrating the power consumption. Thus it has been determined that phosphoric acid for fertiliser can be produced by electric furnaces with cheap power so as to compete with the prices of fertiliser made by the older methods.

## The Canadian-Pacific Liner Empress of Australia.

THE Empress of Australia, which left the Clyde on Friday last for Vancouver, where she is to take up, under the management of Canadian Pacific Steamships, Limited, the Pacific service of the Canadian Pacific Railway Company, is an interesting and notable addition to the company's fleet. In general type and dimensions she is not unlike the Empress of Canada, which was recently completed for the same service by the Fairfield Shipbuilding and Engineering Company, Limited, of Govan, and these two ships are now the largest and finest in the service of the company.

The Empress of Australia was originally ordered for the South American service of the Hamburg-America Line, and was built by the Vulcan Works at Stettin, where she was launched in 1913 and named the Tirpitz. Work on her was well advanced at the outbreak of war; in fact, she was to have been delivered early in September, 1914, but owing to the war and to the uncertain industrial period which followed she was not finished until January, 1921, when, in accordance with the Treaty of Versailles, and after undergoing successful preliminary trials, she was handed over to the Reparation Commission as part of the British reparation tonnage. She was purchased from the British Government by Canadian Pacific Steamships, Limited, which renamed her the Empress of Australia. Since she was taken over the vessel has undergone an extensive overhaul and her boilers have been adapted for oil burning. Several of the public rooms have been refurnished, the state-room accommodation has been modified, and extra provision made for carrying Asiatic steerage passengers. The lifeboat equipment has been brought into line with present-day requirements and new boats of the latest collapsible type have been fitted under the existing lifeboats, which are equipped with Welin electrically operated launching gear.

The principal dimensions of the Empress of Australia are as follows:—Length between perpendiculars, 588ft.; breadth, 75ft.; depth to upper deck, 46ft. 2½in.; gross tonnage, about 21,500. This vessel has accommodation for about 400 first-class, 165 second-class, 360 third-class, and 670 Asiatic steerage passengers, together with a crew of about 520. The view of her which we reproduce above was taken during the recent progressive and full-load trials on the measured mile at Skelmorlie, at which trials we were present. It will be noted that she is of the shelter deck type with a continuous bridge deck which extends for her full length. Above the bridge deck there are upper and lower promenade decks extending to fully half the length of the vessel, and above the upper promenade deck is the boat deck. Below the shelter deck there are two complete 'tween decks, a lower and orlop deck at the far end of the ship, and a lower deck at the after end. The first-class accommodation is arranged on decks A to E, and on deck A is situated the main entrance hall, which is furnished with passenger lifts and two wide staircases leading to the lower decks. Among other public rooms on deck A we may mention the lounge, which is spacious and lofty, a feature of the room being its freedom from pillars, as the roof is built on the cantilever principle with a central decorative glazed dome. Other rooms on this deck are the smoking-room, the ladies' room, and the writing room. The state-room accommodation throughout the ship is exceedingly well fitted up and equipped. On C deck there is the large first-class dining saloon, which, along with two small private dining-rooms leading off the main saloon, provides accommodation for over 370 persons at one sitting. The centre well or dome extends two deck heights and is provided with large windows which open on to A deck passage-way. The second-class dining accommodation is also situated on C deck, as are also the lounge and smoking-room for third-class passengers, similar accommodation for second-class passengers being provided on B deck. The Asiatic steerage passengers are arranged for on E, F and G decks, special kitchens and pantries being provided.




PLAN SHOWING ARRANGEMENT OF MACHINERY, BOILER SPACES FUEL TANKS, ETC.

The plan we reproduce above shows the arrangement of the machinery and boiler spaces, the oil fuel bunkers and cargo accommodation. The ship was designed shortly after the Titanic disaster, and special attention was given to her safety requirements. There is a cellular double bottom extending fore and aft for almost the complete length of the vessel, and the water-tight subdivision of the ship is exceptionally complete. The water-tight doors are operated by hydraulic power and may be controlled individually or collectively from the navigating bridge as well as from the door itself. There is a large installation for wireless telegraphy, and the equipment includes a directional instrument for taking bearings. There is also an emergency plant. The compass is of the gyrostatic type, and with a view to increasing the safety of navigation a submarine signalling gear has been fitted.

The propelling machinery of the Empress of Australia consists of high-speed turbines driving twin propellers through Föttinger hydraulic transformers. The main turbines are of the Parsons drum type with two Curtis impulse wheels, and are designed for a total shaft horse-power of about 18,000, corresponding to a sea speed of 17 knots. As will be noted from the plan, the transformers are accommodated in a separate compartment which may be shut off from the turbine-room by means of the water-tight doors. Under full load conditions the speed of the turbines is about 800 revolutions per minute, the transformers reducing this speed to 150 revolutions per minute at the propeller shafts. Thrust blocks are fitted aft of the transformers and between the turbines and transformers in the turbine-room. As originally fitted these thrust blocks were of the ordinary collar pattern, but it was found to be desirable to replace those between the turbines and the transformers with blocks of the Michell type furnished with independent forced lubrication. This work was carried out by John Brown and Co., Limited, at their Clydebank yard, where the vessel was prepared for sea, and the new blocks have proved very successful. The reversing arrangements are neat and ingenious in design and all the necessary operations can be carried out from the control platform. A reversing engine is fitted to the end turbine, which automatically shuts off the steam to the turbine, operates the pumps for filling the transformer circuits, and again opens the steam when the turbine is moving in the new direction. The reversing gear is quick in action, and we noted that when the turbines were running full ahead the time which elapsed between the astern telegraph command being given and the moment when the shaft began to rotate in the astern direction was not more than twenty to twenty-five seconds. A noticeable feature of the installation is the quiet running of the machinery and the freedom from vibration. A complete service of auxiliary machinery is fitted, and mention may be made of the four auxiliary turbo-generators which are accommodated in a wing of the transformer room. These generators, which supply the power and lighting requirements of the ship, are each of 115 kilowatts capacity and run at a speed of 2200 revolutions per minute. The boilers are fourteen in number and are grouped in two boiler-rooms. They are of the water-tube type, made by the Vulcan Works, and are of a modified Yarrow design working at 250 lb. pressure and furnished with Mumford's feed-water regulators. Each boiler has three furnaces and is fitted with the Vulcan oil burning system. Howden's forced draught system is installed.

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COAL, it is reported, has been discovered on a farm two miles from Vredefort, South Africa, at a depth of 65ft. The seam is thick, and the coal is of excellent quality.

# Letters to the Editor.

*(We do not hold ourselves responsible for the opinions of our correspondents.)*

## AVOIDABLE WASTE IN LOCOMOTIVE OPERATION.

SIR,—I would like to offer a few remarks in connection with the discussion in your columns on "Avoidable Waste in Locomotive Operation."

The letter of your correspondent "C. R. K." in the issue of April 28th of THE ENGINEER appears to be a diatribe against "roller" testing plants, and an attempt to extol the virtues of compound locomotives. "C. R. K." says that the consumption of steam per indicated horse-power-hour is from 15 to 20 per cent. greater on the road than on a testing plant. The draw-bar horse-power will be less and the steam consumption per draw-bar horse-power-hour would, of course, be greater on the road, as the engine would have to overcome wind, gradient, curvature, bogie wheels and tender resistance, but I fail to see that this would have any serious effect on the steam consumption per indicated horse-power-hour. Perhaps your correspondent can explain why the Pennsylvania's De Glehn compound gave better results on the road than it did on the testing plant.

It is intimated that the figure of 15.4 lb. of steam per indicated horse-power-hour is exceptionally low for the Pennsylvania Railroad 2–10–0 locomotive. It may be mentioned that a minimum of 14.9 lb. has been reached with these engines, and in twelve tests the steam consumption was 16 lb. or less per indicated horse-power-hour.

The 2–8–0 engines "Gruppo 735," built by the American Locomotive Company for the Italian State Railways, are referred to as "the most efficient type of American Schmidt superheater locomotives." These little consolidation engines belong to a type now regarded as practically obsolete by most American railways. Certainly they cannot hope to equal the economical boiler performance of our 2–8–2 and 2–10–2 engines. Nor do I believe that running a locomotive with 4ft. 6in. coupled wheels in express passenger service is conducive to the best results. Nevertheless, it is admitted that the "Gruppo 735" ran on the same quantity of fuel and water per unit of work as the Italian-designed 2–8–0 engines, "Gruppo 740"—a rate of 15.8 lb. of steam per indicated horse-power-hour was attained in one test with locomotive 735015—and proved themselves of equal power, although 2½ tons lighter than the Italian-built locomotives. The American machines evidently gave satisfaction, as an order for additional locomotives of the same type was later given to the same builders.

"C. R. K." also refers to Pennsylvania Railroad engine No. 3395, Class "K 29 s," which is the only engine of its class, and was built solely as an experiment. Much better results as regards power have been obtained with the E 6 s "Atlantic" and K 4 s "Pacific" locomotives, both two cylinders simple superheated engines.

The best results with compound locomotives heretofore published are those obtained on the Paris, Lyons and Mediterranean Railway some years ago, when a minimum steam consumption of 13¼ lb. per indicated horse-power-hour was reached. If "C. R. K." has any data concerning any engine capable of giving an indicated horse-power on 11¼ lb. of steam per hour, he certainly owes it to the engineering profession to publish full particulars of such tests, or give reference to the source from which they can be obtained. He proposes, on page 477, an engine with two 27in. high-pressure cylinders, requiring two 43½in. low-pressure cylinders. Such cylinders may do very well for "Mallet" engines, but how could they be fitted to a "Pacific" engine within the present-day loading gauge? The adhesive weight necessary for an engine with such cylinders would be far beyond that which could be provided on six coupled wheels.

"C. R. K." also refers to the Von Borries compound tested at St. Louis in 1904, and says that the steam in this engine was just "dry." The records show that the superheat varied from 160 deg. to 192 deg. Fah., which is rather more than dry. He also mentions that the Von Borries engine weighed 59 tons, and goes on to describe the excellent performance of the Prussian-Hessian class "S-9," but does not say that the class "S-9" were much larger machines, weighing 75½ tons, nor does he state that they were afterwards built with Schmidt superheaters. Surely it is well known that the latest Prussian-Hessian locomotives of 4–6–0, 2–8–0, 2–8–2, and 2–10–0 types are all three-cylinder simple superheated engines.

The compound—except the "Mallet"—is dead in this country, and no one can say that it has not had a fair trial. There is no doubt of its ability to effect some saving in water and fuel, but the increased cost of maintenance more than offsets any saving. The Atchison, Topeka and Santa Fé Railway has had as much as, if not more, experience with compound engines than any railway in the world, and it may be of interest to note that the company has recently converted thirty-six four-cylinder superheated balanced compound "Pacific" engines, far larger than any express engines in Europe, to two-cylinder simples with most satisfactory results.

The table below may be of interest in connection with the foregoing remarks, and to show that the simple engine can now very nearly reach the maximum output per ton of weight of which the compound is capable. I have not considered the Portuguese State locomotives, as there seems to be something unusual about their "record." Their maximum of 2214 indicated horse-power, said to have been attained at a speed of 63 miles per hour on level track, was made with a train of 388 tons behind the tender. Now this train would certainly not require more than 1000 horse-power, leaving 1214 horse-power to be absorbed by the 123-ton engine and tender. Obviously there is some error in the figure quoted.

| | P.R.R. K 4 s. | P.R.R. E 6 s. | P.R.R. I-1-s. | P.L.M. (France) 4-cyl. superheated compound. |
|---|---|---|---|---|
| Weight of engine, English tons .. | 138 | 107 | 161 | 91 |
| Maximum I.H.P. .. | 3184 | 2489 | 3480 | 2391 |
| Speed at which developed, m.p.h. .. | 47 | 56 | 25 | 50 |
| Horse-power per ton of engine .. .. | 23 | 23.3 | 21.7 | 26.3 |

Mr. F. W. Brewer's letter in your issue of May 19th raises the question of the utility of the ton-mile as a unit for comparative purposes. In my opinion, it is practically useless in this respect, as any results based on it will necessarily vary according to the gradients and curvature of the railways considered. It requires little engineering knowledge to realise that it will require a greater fuel consumption to haul a ton one mile up a 1 in 40 bank than it will to haul the same ton one mile on a level track. The Italian unit of "virtual ton-kilometre" would appear to be far more suitable.

The Virginian Railway record mentioned by Mr. Brewer can be partly explained by the fact that the divisions on which it was made are largely down-grade in the direction in which the test trains were moving, and consequently the locomotive was not being worked, but was coasting or drifting much of the time. These engines were designed for helper service on 1 in 48 banks. I have not seen any published results of their coal consumption per 1000 ton-miles on this bank, but am willing to wager that it is greatly in excess of 26.9 lb. I have looked up the records of a number of tests made with superheater engines in recent years, and find figures varying from 45 lb. per 1000 ton-miles on lightly graded lines to nearly 400 lb. on ascending mountain gradients. It is impossible to compare the performance of any two engines based on the ton-mile, unless the gradients, curvature, and speed are similar in both cases.

I apologise for trespassing at such length on your valuable space.

Texas, June 10th. WM. T. HOECKER.

## A CAUSE OF UNEMPLOYMENT.

SIR,—With the settlement of the dispute in the engineering industry, it would appear a favourable time to draw attention to one of the reasons for lack of work and employment.

The manufacture of motor vehicles, which is the youngest but not the least important branch of the industry in this country, seemed before the war to have passed through its initial difficulties and to give every prospect of becoming one of the most important in the country. It had been built up with great difficulty and without the assistance of any tariff. A really good export business had been commenced in our Colonies and Dominions, and in other overseas markets as well. During the war these markets could not be supplied, and American manufacturers, who had done next to nothing in the way of supplying commercial vehicles, seized the opportunity to make the most of them. Not only the American manufacturers, but the Italians, who somehow managed to make vehicles for export during the war, also took advantage of the British makers' inability to supply. When British makers were able to manufacture again for export, they found their overseas markets had been captured, and that there were such large stocks of vehicles already there that very little business could be done, and many of the firms who took the risk of sending out vehicles in the hope of sales have them still on their hands.

On the conclusion of peace, there was for some time a good demand for vehicles in this country, but foreign makers immediately started to compete. A 30 per cent. duty was placed on pleasure cars, but for some reason politicians decided that commercial vehicles should come into the country duty free. Large numbers of American make, having been produced in a country which had the foresight to protect its own home market and enable manufacturers to produce in enormous numbers, were shipped here at prices with which British makers could not compete, largely due to their being only able to manufacture in much smaller numbers. The continental manufacturers, with depreciated exchanges, have continued to supply vehicles of all sorts at prices which would not pay for the material alone here. Barge-loads of Italian vehicles can be seen passing up the Thames daily, and now German vehicles are at work in the London streets. Recently a large advertisement was to be seen in one of the daily papers calling attention to the reductions in prices of one of the leading British makes. On the same page there appeared an advertisement calling attention to the possibility of taking immediate delivery in this country of new vehicles of the same capacity, "of excellent design and workmanship," of German make, at one-third the price of the British lorry.

Some politicians say that when we buy manufactured articles from abroad, it is for the good of the country to get them cheaply, and in any case it is the only way the German war indemnity can be paid, to take goods from them. But while this is going on, British mechanics cannot find employment, and those who have invested savings in factories specially put down to make motor vehicles get no dividends and lose their money.

With the exception of some few of the companies which have catered for the demand for a small car, it is doubtful if there are any in the country which are not working at a loss. The balance sheets of some of the leading companies recently published show the extent of the losses.

If the Government and the Members of Parliament who profess to be doing their best to relieve unemployment, will not take any steps to help protect the British manufacturing motor industry, which is quite distinct from that of the middleman and importer, and surely more important to the country, will not mechanics in want of employment and the shareholders who have invested their money take some joint action to impress on the Government the advisability of putting a stop to the free importation into our home markets?

The extent to which the overseas markets can be recovered is very uncertain, in view of the tendency to try and develop home industries in many of them by import duties, amounting to as much as 60 per cent. on spare parts in Australia.

The protected American market is now booming, and vehicles are being manufactured there in such enormous numbers that they can be offered for sale abroad at prices with which British vehicle manufacturers cannot compete. This makes it more than ever necessary to preserve our home market for British manufacturers.

London, S.W. 1, June 20th. J. E. THORNYCROFT.

## THE CAUSE OF TRADE CYCLES.

SIR,—In your issue of the 9th inst., referring to fluctuations in trade, you say: "Whether or not there is a solution to that century-old problem, we are unable to say, but this we do know, that no research could be more valuable than one that found it."

It so happens that I have devoted considerable time to this problem. May I, therefore, indicate as briefly as possible some of the conclusions at which I have arrived?

The sequence of cause and effect appears to be as follows:—The normal tendency is for trade to expand under the stimulus of invention and ordinary human activity. Expanding trade calls for more and larger bank loans. Mr. Reginald McKenna, chairman of the London, City and Midland Bank, tells us that bank loans cause inflation and send up prices. Rising prices stimulate trade expansion still further. Bank credit continues to grow in volume. But at the same time, trade expansion calls for bigger cash withdrawals from the banks. More money is required for wages payments, more must be kept in pocket and till for immediate requirements. So the banks find themselves faced with a growing volume of credit and dwindling cash reserves. The bankers know from experience that it is not wise to fall much below 15 per cent. cash reserve, as they are liable to pay cash on demand against the full amount of their loans. And having lent a great deal more than they actually have in cash, they begin to feel very uncomfortable under continuous trade expansion. They must avoid instability in finance, whatever the cost to industry. So lending is restricted, loans are called in, up goes the bank rate, down come prices, trade slackens off, unemployment increases. The result of this is to make the banks' position more "liquid," *i.e.*, a more stable ratio between cash and credit is attained. The bankers in due course find themselves with an excessive margin of safety, which to the banker means bad management. Full advantage is not being taken of lending powers. Down comes the bank rate again—gradually, of course—but as there is a considerable time-lag in all matters industrial, this tendency to over-stability continues to manifest itself. When people have been "bitten" by a slump in trade, they are slow to recover confidence and take full advantage of bank-rate reductions. Thus, in April, 1921, the bank rate was 7 per cent. It has now come down to 3½ per cent. In a leading article, the *Financial News* comments on this as follows:—"During this period the general banking position . . . has moved steadily towards stability . . . there has been an increase all round in the ratio of cash to deposits." I should explain that, as is usual with most financial jargon, the word "deposits" has two meanings. It is used here to mean "loans" and not cash deposited with the banks by customers.

In simple language, the banks are now doing their utmost to stimulate borrowing with a view to reviving trade. But, unfortunately, they so very nearly "killed the goose" in their last orgy of credit restriction that they are faced with a problem in resurrection rather than revival. For reasons which cannot be gone into here, they were late in putting the financial brake on trade expansion in the autumn of 1920, so they tried to make up in severity what they had lost in time. The appalling results on industry we are all only too familiar with.

However, unless—as many people begin to believe—we have exhausted the possibilities of the present financial system, their effort will no doubt produce results in due course. Allowance must be made for the time-lag already mentioned. There may be another trade boom some day, although I confess to being among the sceptics so far as our existing financial system is concerned. But be that as it may, there can be little doubt, I think, that the cause of trade cycles is primarily financial. Finance holds the whip hand; and so long as the present financial system continues, whereby the interests of bankers are inherently antagonistic to continuous trade expansion, we must expect such alternations of prosperity and depression.

Gloucester, June 10th. HUGH P. VOWLES.

## BRITISH EVAPORATION UNIT.

SIR,—Why do we continue to use the extremely cumbrous and inconvenient phrase "pounds of water evaporated as from and at 212 deg. Fah."? We do not express the calorific value of a fuel as so many "pounds of water heated 1 deg. Fah. at its mean specific heat between 32 deg. and 212 deg." To express this meaning we say simply "British thermal units," written B.Th.U., and everyone knows what is meant.

Similarly, I suggest that it would be a real advance in engineering terminology if the total output of a boiler or similar quantity could be plainly defined as so many "British evaporation units." This could be written B.Ev.U., or B.E.U., if the omission of the "v" could lead to no misunderstanding. There would then be the relation—using Professor Callendar's figures—1 B.Ev.U. = 970.74 B.Th.U., analogous to the well-known relation 1 B.Th.U. = 778 foot-pounds. Other authorities give for the ratio between the B.Ev.U. and the B.Th.U. numbers differing slightly from 970.74; for instance, Professor Peabody gives 969.7.

This is, of course, only a question of a name, but yet it is a matter of considerable importance. In mathematics and other branches of science advance has frequently been greatly assisted by the use of an improved terminology or a more compact symbol. It is certain that the use of the phrase "British thermal unit" itself has greatly helped the general understanding of heat quantities and relations.

The use of some such unit as the British evaporation unit is a necessity. It is impracticable to state, for instance, the output of a boiler in B.Th.U. per hour; the numbers become too large and too remote from the quantities actually measured. Also the actual quantity of water evaporated is inadequate as a measure, especially under modern conditions, when factors of evaporation of 1.3 and above are by no means uncommon. The same question arises in statements of the performance of heat engines, and the steam consumption might very conveniently be given as so many B.Ev.U. per indicated horse-power-hour.

This quantity is thus continually being used in practice, and it most certainly should have a more handy name than the cumbrous phrase now used, the meaning of which is not always clearly understood. I believe that the term "British evaporation unit" supplies what is wanted, and shall be glad to see any comments on this suggestion.

Bolton, June 21st. G. A. ROSSETTI.

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THE "Returns of Accidents and Casualties" for the year 1921 were issued as a Stationery Office publication on the 16th instant. In comparison with the figures for 1920 they show a great improvement in nearly every item. This does not, however, mean that the working of the railways is as much safer as the figures suggest, since the decreases are mainly due to the considerable reduction in the freight traffic last year. On reference to the various companies' annual reports, we find that the thirteen principal British companies reduced their goods train mileage by 24.26 per cent., and their goods shunting mileage by 25.11 per cent. No wonder, then, that, for instance, the number of collisions between goods trains fell from 187 to 85, of goods train derailments from 472 to 319, and broken couplings from 11,113 to 7850.

# A Seven-Day Journal.

## Motor Car Research.

THE second annual report of the Research Association of British Motor and Allied Manufacturers covers the first full year of the Association's active existence. Fifteen firms are now members of the body, with one associate member firm. The Association's laboratories are established at Chiswick, and are under the charge of Mr. H. S. Rowell. During the past year, a large volume of research work was initiated, and from the report it is evident that, unlike some of the other research associations, the British Motor Manufacturers' Association is a very energetic organisation, and is doing excellent work. At the same time, it is clear that some motor firms, by no means insignificant in numbers or importance, have yet to be convinced that co-operative research can yield results of benefit to themselves. Chief among the researches which were begun or continued during the year were those dealing with gear box noise, systems of suspension, carburation and radiators. In addition to carrying on research work of its own, the Association is actively co-operating with other research associations on subjects of kindred interest. Thus, in conjunction with the British Cast Iron Research Association it is investigating cast iron cylinders, and with the British Non-ferrous Metals Research Association it has begun a research on die castings.

## Richardsons, Westgarth, and Diesel Engines.

IN the annual report of the directors of Richardsons, Westgarth and Co., Limited, it is recorded that the firm has arranged a licence with Messrs. Beardmore to manufacture Diesel oil engines of the Beardmore-Tosi type. In order to meet the considerable expense involved in the development of the new department, the directors have set aside a sum of £50,000 for the current year. We understand that the first vessel equipped with Diesel engines by the firm is to be submitted to trials under the scheme now being organised by the Institutions of Civil and Mechanical Engineers and the Naval Architects.

## Marine Aircraft for Cross-Channel Work.

A NEW cross-Channel air service, to be operated under the Government's subsidy scheme, has received the sanction of the Air Ministry, and will, it is expected, shortly be at work. The service, unlike those in existence at present, will be operated by means of marine aircraft built by the Supermarine Aviation Works, Limited, and will provide connection between Southampton, Cherbourg and Le Havre. Several shipping companies are financially interested in the scheme, for one of its main objects will be to shorten the Transatlantic route by picking up passengers at Cherbourg and conveying them to Southampton, whence they will proceed by train to London. The promoting company in this connection is co-operating with the London and South-Western Railway. Later on, an air service to and from the Channel Islands will be instituted. The company is to receive a subsidy of 25 per cent. of the gross earnings, together with a payment of 30s. per passenger, and 1½d. per pound of goods carried. The latter rates are half those paid by the Government to approved companies operating on the London–Paris route.

## Restoring the Victory.

THE Society for Nautical Research, of which Sir Doveton Sturdee is President, has taken the initial steps towards restoring the Victory to the same appearance as she possessed in Nelson's day. An expert report on the work required to be done to this end has been drawn up, and an estimate of the cost involved has been obtained. The Society has already manifested its interest in the historic vessel, for it was it that was mainly responsible for the recent steps taken to secure the preservation of the Victory by removing it from the waters of Portsmouth Harbour to dry dock.

## Wireless Broadcasting Difficulties.

DIFFICULTIES, it would appear, have arisen in connection with the carrying into effect of the schemes of wireless broadcasting concerning which much has recently been heard. The British manufacturers of wireless apparatus are more numerous than the number of broadcasting stations which the Postmaster-General will allow to be erected. As a result, either some scheme of sharing the cost of running the broadcasting stations will have to be instituted, or manufacturers undertaking the broadcasting work will be placed at a prohibitive disadvantage relatively to manufacturers who do not broadcast. The expenses of broadcasting are bound to be very considerable, yet the only practicable way in which to meet them is to recover the outlay on the profits derived from the sale or hire of the receiving apparatus. The difficulty in this respect arises even more acutely in connection with the foreign manufacturer of receiving sets, for he will not be called upon to share any expense for broadcasting, and, in addition, will by reason of his depreciated currency be able to undersell our own makers. We notice that the Federation of British Industries is interesting itself in the matter, and has urged the Postmaster-General to impose the condition that only British-made apparatus will be permitted in the industry.

## Edinburgh's Electric Tramways.

ON Tuesday the first section, extending to a length of a little over three miles, of Edinburgh's new electric tramway system, was formally opened. After the expiry of the lease of the old tramway company in July, 1919, the Corporation devoted much attention to the question of improving the services provided by the existing cable-operated trams. High costs prevented the immediate electrification of the system, and for a time motor omnibuses were used instead of the trams on certain of the routes. In April of last year, however, electrification was decided upon, with the result that a section from Liberton to Pilrig, giving connection with the Leith and Granton electric systems has now been brought into use, while other routes are being actively prepared. The question of electrifying the route running down Princes-street gave rise to much discussion and opposition, but eventually, after a Ministry of Transport inquiry into the matter, the Corporation was authorised to undertake the work, with the overhead conductor wires carried on central poles. The double-deck cars to be used are equipped with motors of 42 horse-power, carry sixty passengers and cost about £1800 each.

## Telephone Developments.

LAST Friday in the House of Commons Mr. Kellaway received authority to raise 15 million pounds for improving the telephone system by way of capital expenditure. This sum, it is estimated, will last until April, 1924. A programme of work for the next five years has been prepared and will involve the expenditure of a total of nearly 36 millions. The portion of the expenditure for which Parliament has now provided the necessary authority will cover the provision of new exchanges and the extension of others, and the continuation of the work of relaying all the trunk lines below ground. Dealing with automatic telephone systems, the Postmaster-General said that in America the demand for them arose from the companies, and not from their subscribers. As for their use in London, he would not, he said, feel justified in asking for authority to expend money on them until a workable and trustworthy system could be obtained much more cheaply than was the case at present.

## Six-wheeled Motor Vehicles.

CERTAIN tractor and trailer combinations have recently been placed upon the road, in which the trailer when in use has only two wheels on the ground, part of the weight carried by the trailer being borne by the tractor. The Ministry of Transport has decided that as experience may lead to considerable alteration in the design and construction of such combinations, it is not desirable for the present to deal with them by special regulations, but rather by amending the existing regulations governing heavy motor cars and trailers. It has accordingly issued to all local authorities an amending order, under which the permitted axle weight of a trailer is increased from 4 to 6½ tons, the sum of all the axle weights of the car and trailer is raised to a maximum of 22 tons, and the maximum speed for any heavy motor car fitted with resilient tires when not drawing a trailer is fixed at 12 miles per hour. In the case of the special tractor and trailer combinations to which the order relates, a maximum speed of 12 miles per hour will be permitted if all the wheels are fitted with soft tires, and if the total length does not exceed 33ft.

## Electrically Propelled Fruit Carrying Vessel.

IT is reported that negotiations are proceeding between a Birkenhead shipbuilding firm and one of the large fruit-importing lines for the construction of two or possibly three vessels. One at least of the vessels, it is said, will be electrically driven by means of an oil engine-generator-motor combination.

## Scottish Electric Developments.

THE Town Council of Blairgowrie, Perthshire, is favourably considering a scheme for generating a local supply of electricity from the waters of the river Ericht, supplemented possibly by a small auxiliary plant. The estimated cost of the supply is 8d. per lighting unit and 3d. per heating unit. If energy should eventually be obtainable on favourable terms from the Grampian Company, the Town Council considers that it would be able to dispose of its generators and arrange to receive a bulk supply. The river Ericht referred to is a second river of the same name, and is not the Ericht flowing from Loch Ericht into Loch Rannoch, which river is within the domain of the Grampian hydro-electric scheme. The Loch Doon hydro-electric scheme, to which reference was made in the Journal on May 19th, may possibly be abandoned by the Corporation of Ayr, for a proposal is now afoot to form a joint electricity board for Ayrshire, as a result of a provisional agreement between the Ayr County Council and the Borough of Kilmarnock. The Kilmarnock power station would form the centre of supply, and a sum of about £200,000 would be required for capital expenditure.

## Railways and Road Traffic.

REPORTING to Parliament regarding the outcome of its inquiry into the North-Western and Midland Railways Road Transport Bill, the Private Bill Commitee, presided over by Lieut.-Colonel Walter Guinness, criticises the Ministry of Transport for causing unnecessary expense to the parties concerned by reason of its delay in disclosing its objection to the principle on which it was proposed in the Bill to levy the charges for the conveyance of merchandise by road. Although the Committee was not enabled to hear the petitioners' full case, it expresses the view that, subject to the possibility of the elimination of unfair competition, it would be in the public interest to allow the railway companies concerned to participate to the fullest possible extent in the competition for road traffic. The Minister of Transport, in attempting to defend the Ministry's action, endeavoured to show that the Bill had been somewhat hastily withdrawn by the promoters, but in view of the opinions expressed by the Committee there can be little doubt that the Ministry in acting as it did laid itself open to deserved censure.

## The Capsizing of a Brazilian Steamer.

AN extraordinary, and so far unexplained, accident occurred to the Brazilian Lloyd steamer Avare, 8227 gross tons, while being towed out of dock at Hamburg on Friday morning of last week. She had hardly passed through the dock gates when she listed to port, and then, when tugs endeavoured to right her, suddenly to starboard. Before efforts could be made to save her, she capsized, with the result that over a hundred of the crew and workmen on board at the time lost their lives. It is believed by some that the accident was caused by the vessel being allowed to leave the dock without sufficient ballast.

## After the Dispute.

IN view of the fact that all the other unions involved in the recent dispute in the engineering industry had accepted the employers' terms and were returning to work, it was anticipated that the boilermakers would not long persist in their attitude of standing aloof from the general settlement. This anticipation proved correct, for on Tuesday it was officially intimated that the Boilermakers' and Iron and Steel Shipbuilders' Society had agreed to accept the terms arranged with the other unions. The lock-out has thus been completely lifted. Reports from the engineering centres indicate that every effort is being made to restore the industrial situation to the status of March 11th, but that time will be required to do even this much, let alone to register an advance farther along the road to renewed prosperity. A certain amount of quickening of activity in the way of inquiries and orders has been experienced in some quarters, but in general there is still insufficient work available to permit all the men formerly in employment to be re-engaged.

## Surplus War Stores.

IN his annual report for 1921–22 Sir Howard Frank, chairman of the Disposal and Liquidation Commission, records the fact that since the Armistice until March 31st of this year the sum of money brought in by the sale of surplus Government property amounted to over £624,680,000, of which about £32,000,000 represented the proceeds of sales during the year covered by the report. Of the stores reported up to March 31st as available for disposal, about 87 per cent. has been sold. The report further records that no reasonable offer has yet been received for the purchase of the Gretna factory as a whole, and that it will probably be decided to dispose of it in separate lots. The contract with the Slough Trading Company came to an end on April 6th last, and all mechanically propelled transport material reported for disposal after that date will be offered for sale by the Board itself. The Board announces its intention of giving British makers the opportunity of purchasing vehicles of their own manufacture, provided they are prepared to pay satisfactory prices.

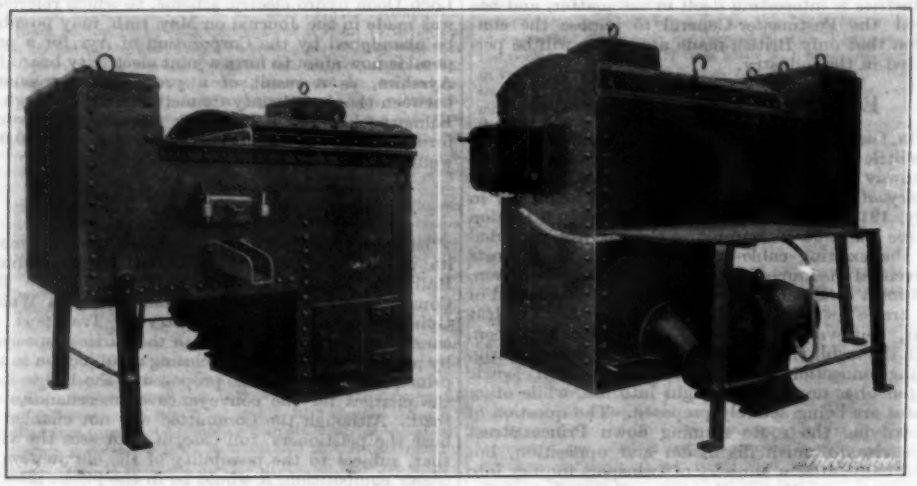
## The Foundry Trades Exhibition.

No. II.*

WE continue below our description of some of the exhibits at the International Foundry Trades Exhibition, which is being held in the Bingley Hall, Birmingham, and which will be closed to-morrow, Saturday, the 24th.

The Morgan Crucible Company, Limited, Battersea Works, Church-road, London, S.W. 11, has what is probably one of the most novel exhibits in the form of some electrically heated crucibles, one of which was actually at work in the model foundry attached to the exhibition. The novelty about these crucibles is the fact that they themselves form the heating element, that is to say, the current is passed through the crucible itself and in its passage raises the temperature of the whole mass. There are no metallic conductors beyond the terminals, as the material of which the pots are made is of such conductivity that it will pass the necessary current and will absorb all the voltage. The result is, of course, that a high efficiency is obtained, as the heat is brought as near the charge as possible, and it can also be concentrated by adjusting the thickness of the crucible walls at the most advantageous depth. These pots are generally arranged to work with a comparatively low voltage, but the adaptability of the idea may be judged from the fact that the one with which demonstrations are being given is connected directly across a 400-volt circuit. This pot is, nevertheless, rather in the nature of a *tour de force*, and the arrangement was only adopted to meet the exigencies of the exhibition supply. Another application of the same material is in the manufacture of hot plates, and several are shown in circuit. It is noteworthy that the surface of these plates is vitreous, so that they will withstand acids, and they are not damaged by water dropping on them when they are hot. They can be made for any temperature between 50 deg. and 1350 deg. Cent. Included among the other exhibits on this stand there are some crucibles made by a new process, which have such a high conductivity that a saving of 20 per cent. of fuel can be made by their use.

British Reverberatory Furnaces, Limited, 82, Victoria-street, London, S.W. 1, are exhibiting the new furnace shown in Figs. 7 and 8, which is specially intended for taking the place of the crucible furnace in melting copper, brass and other alloys. The furnace shown is of ½-ton capacity. It has a combustion chamber, equipped with forced draught, at one end, a working bed with a vaulted roof in the centre, and a combined uptake and metal feeding hopper at the other end. Doors are provided for attending to the fire, and charging holes are arranged in the roof. The convenience of melting brass in a bath, from which it can be tapped as required, will be readily appreciated, and should make the furnace very popular, provided that the system does not involve any drawbacks, but it appears from the experience of users that it is a thoroughly satisfactory arrangement. Melting is effected much more quickly than is possible with crucibles, and it is claimed that that is the reason why alloys can be melted in the new furnace without serious loss. The loss is, in fact, said to be less than is the case with crucible melting, while much larger pieces of cold metal can be put in the bath and quickly melted.



FIGS. 7 AND 8—HALF-TON REVERBERATORY MELTING FURNACE

The Universal System of Machine Moulding and Machinery Company, Limited, 97, Queen Victoria-street, London, E.C. 4, has a fine display of moulding machines manufactured under the patents of MM. Bouvillain et Ronceray, one of which is illustrated by Fig. 9. This machine is of the hydraulically operated type, and is noteworthy on account of its high rate of production, two men, it is claimed, being able to complete, on it, 400 moulds in eight working hours. The size of the mould is about 17in. by 12in. The machine rams the top and bottom mould in one operation, withdraws the pattern plate, closes the box on the machine, and then pushes the mould completely through the box, so that castings can be made without the boxes. Among the other machines exhibited, one of the most interesting is a jolt ramming machine operated by hydraulic power, which is said to be far more efficient than the usual pneumatic type.

Alfred Herbert, Limited, Coventry, has a stand on which there are shown some hardness-testing machines, a Norton grinder, and the sand-mixing machine shown in Fig. 10. This machine comprises a pedestal carrying two vertical spindles rotating at a high speed, one within the other. The spindles are driven in opposite directions by bevel gearing from a pulley on a horizontal shaft. The upper ends of the spindles carry two cages, the bars of which, passing each other in opposite directions at a great speed, do the mixing and disintegrating. The cages are covered by a dome-shaped casing which directs the mixed sand on to the floor and prevents it from flying about. The centre of the dome carries a hopper, into which the unmixed sand is fed, and from which it drops into the centre of the cages. The hopper can be lifted off for the purpose of cleaning and for removing hard matter which may be caught by the bars. The machines are not built in the rough way customary with foundry machinery, but are constructed for long life and durability. All the gearing is of case-hardened steel, and all the bearings are ball journal and thrust bearings. The gearing and bearings run in an oil bath and are thoroughly protected from the entrance of dust or sand. The cages are of steel, and the bars are so arranged as to be easily renewed.

The Foster Instrument Company, of Letchworth, has several machines intended for testing the products of iron foundries, and among them the Eden-Foster repeated impact testing machine, shown in Fig. 11, which follows closely on the lines of experiments by Dr. T. E. Stanton. The machine operates by means of a falling hammer of known weight, which drops freely and vertically upon the test piece from a known height. Thus the energy in the blow can be calculated with very great exactness. After each blow, the hammer being meanwhile lifted, the test piece is rotated through 180 deg., and again the hammer falls from the same height. This process is repeated automatically by the machine a very large number of times, the number of blows being recorded on a counter. When the test piece breaks the machine is automatically thrown out of gear and stopped. The test piece has a groove turned in the region of impact, localising the stresses in the manner developed by Dr. T. E. Stanton. Two hammers of different weights are provided, so as to give a wide range to energy of blow. With the lighter hammer—2 lb.—the machine can be run at 90 blows per minute, while with the heavy hammer—5 lb.—the best speed is about 60 blows per minute. Rigidity of the machine is, of course, essential to produce accurate results with this system of testing, and the mounting of the test piece is thus very strong and rigid, so that it

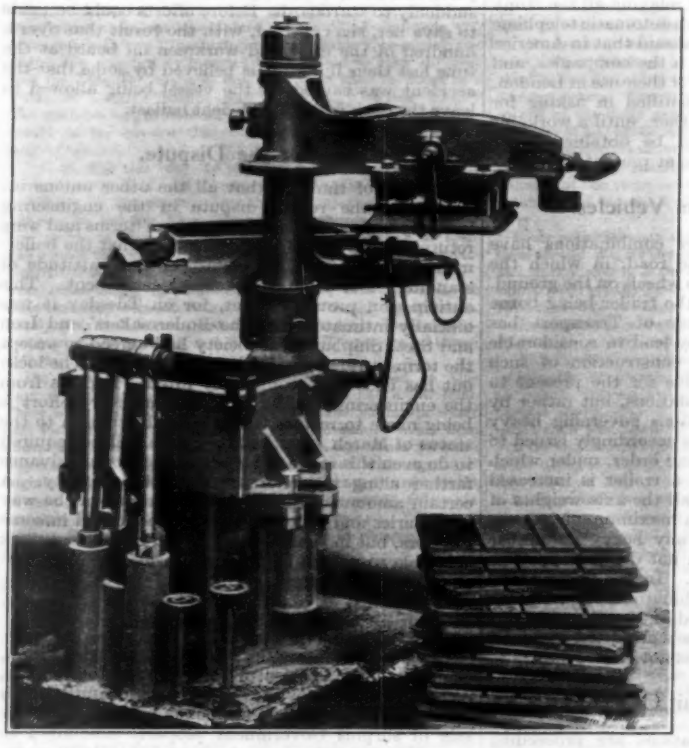


FIG. 9—HYDRAULIC MOULDING MACHINE

FIG. 10—SAND MIXING MACHINE

* No. I. appeared June 16th.

makes no difference to the results of tests with this machine, so we were told, whether it is mounted on a concrete bed or on a wooden bench.

The Adaptable Moulding Machine Company, Stanhope-street, Birmingham, has a large stand on which there is exhibited a large variety of moulding and allied machines, among which there is the duplex roll-over machine illustrated by Fig. 11, that has a 12in. draught and is suitable for deep green sand cores or moulds. The mould or core is turned over about its centre of gravity, thus requiring the least possible amount of energy for the purpose. The moulds can also be rammed up near the floor line, resulting in a saving of labour during the ramming process. The machine is duplicated on each side of the central column, and each side can be used independently of the other. If desired, the machines can be fitted with a special bracket to carry match plates. There is also an adaptable core machine for split core boxes having a draw of 12in. Existing core boxes can be fitted, and the machine is so designed that the core box carriers can be moved into the horizontal position for ramming up intricate pockets. A piston type core machine, designed for the production of piston cores on quantity basis, is also exhibited. The core is rammed up on a table which is adjustable to suit the height of the core box, and is then rolled over on to another adjustable table, the opening movement being 6in. In the case of the duplex sifter—shown in Fig. 12—the riddles can be changed whilst the machine is in motion, thus enabling two grades of sand to be worked with one machine. All the working parts are totally enclosed, and the power required is said to be only some 60 watts.

The Cambridge and Paul Instrument Company, Limited, has on its stand a collection of devices for the foundry trades, including electrical $CO_2$ instruments, electrical distance thermometers, draught and pressure gauges, resistance thermometers, thermo-electric pyrometers, radiation and optical pyrometers, mercury-in-glass thermometers, and a new automatic temperature regulator, several of which items we have already dealt with.

The draught and pressure gauges illustrated by Fig. 14 are designed for recording vacua, and pressures up to 500 lb. per square inch. The recorders have circular charts 9½in. diameter, and the pressure to be measured acts on a Bourdon spiral, the movements of which are communicated to a pen which moves over the revolving chart. They give permanent records extending over twenty-four hours or seven days as required. The dial gauges shown are for indicating draught or pressure up to 6in. of water. A selection of mercury-in-steel, mercury-in-glass, and dial thermometers is also exhibited. The mercury-in-steel thermometers are suitable for ranges up to 1000 deg. Fah. The principle upon which the working of this instrument is based is as follows:—A steel bulb is connected, by means of steel capillary tubing, with a special form of Bourdon spiral, the whole system being filled with mercury. Any changes in the temperature of the bulb give rise to corresponding changes of pressure in the systems which are magnified, and are communicated to a simple pen or pointer in connection with the Bourdon spiral. The bulb may be placed as far distant as 75ft. from the indicator. The recording thermometer or thermograph is shown in Fig. 15. Any thermograph or index thermometer may be fitted with an electric alarm attachment by means of which a bell is rung immediately the temperature exceeds or falls below the pre-determined value; or, if desired, a double attachment, arranged for giving warnings of both maximum and minimum temperatures, may be fitted. The dial thermometer—as shown in Fig. 16—is very similar in principle. The temperatures are measured by making use of the variation in vapour pressure of a liquid. An instrument consisting of a bulb containing a volatile liquid—ether being the liquid generally used—is connected by capillary tubing with a Bourdon spiral. Changes in the temperature of the bulb cause relative changes in the vapour pressure, which give rise to the movement of the Bourdon spiral; these movements are communicated to the pointer moving over the dial, graduated in degrees of temperature. The range of this instrument is not so great as the mercury-in-steel type, being only between 360 deg. and 205 deg. Cent. These instruments are made with both flexible capillary tubing and also with a rigid stem, the dials are 6in. diameter, and the actual length of the scale is approximately 12in.

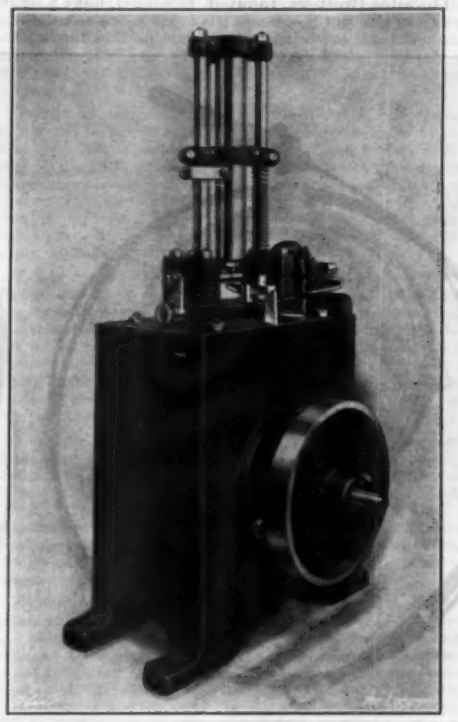


FIG. 13—REPEATED IMPACT TESTING MACHINE

The relay for automatic temperature control referred to above consists of a millivoltmeter calibrated in degrees of temperature for use with a thermo-couple. Near the extreme end of the pointer of the millivoltmeter is attached a light thermo-couple which is electrically connected with a moving-coil relay. A small platinum spiral, which is heated electrically, can be placed at any desired position on the scale in front of the galvanometer, but in such a way that it does not prevent the free movement of the pointer. In order to control the temperature of a furnace, a thermo-couple is placed in it and is connected with the millivoltmeter. The heated spiral is set at the required temperature by means of the scale. When the furnace reaches this temperature the thermo-couple mounted on the pointer is brought opposite the heater and becomes heated, thus generating a small current which operates a relay. This relay in turn closes an electrical circuit which operates a valve controlling the gas supply of the furnace.

W. and T. Avery, Limited, Soho Foundry, Birmingham, have two stands, on which there are displayed representative examples of the various types of testing machines which they manufacture, and which have mostly been described in THE ENGINEER in connection with other exhibitions. There is also the "counting" machine shown in Fig. 17, which has recently been devised for checking the numbers of light articles that are too small to be counted individually. It really consists of a weighing platform with two steelyards. One of the steelyards is provided with a tare balance, and with it the weight of a container full of articles is balanced. The weight is read off and the slider returned to zero. Ten of the articles are then taken from the lot, put in the receptacle hanging from the upper steelyard, and its carriage is moved along until a balance is obtained. The number of articles in the container can then be read off directly on the steelyard. The reason why ten articles are taken, rather than a smaller number, for the second balance, is that a better average is provided. The principle of the machine is so obvious that it needs no explanation, but the variety of its applications is astonishing.

Joseph Baker, Sons, and Perkins, Limited, Kingsway House, Kingsway, London, W.C. 2, have as their principal exhibit the sand mixer illustrated by Fig. 18, where it is shown in the tilted position for discharging its contents. The bottom of the trough is formed by two semi-cylinders in which rotate two mixing blades. The blades rotate in opposite directions and at different speeds. The trough is hinged about a pivot at the front, and can be tipped up by means of the hand gear seen on the left, while the blades continue to rotate and thus discharge the contents. The grid, which forms a cover over the trough during mixing, is automatically lifted as it is tipped for discharging. The trough is lined with renewable cast iron plates, and special stuffing-boxes are arranged to prevent the mixture working its way through the trough sides, where the mixing blade axles emerge, and thus finding its way into the bearings.

John Macdonald and Son, Limited, Watt-street, Maryhill, Glasgow, are showing a large variety of British-made pneumatic moulding machines of the orthodox jar ramming type, but their most novel exhibit is a portable petrol-driven air compressor made in Italy. Its outstanding feature is the fact that the two engine cylinders and the two compressing barrels are all cast in one piece, like the cylinder block of a four-cylinder petrol engine. The engine cylinders are those inside and all are water-jacketed. The arrangement has, of course, the advantage that there is no transmission gearing between the two parts of the unit. The motor cylinders are 4in. in diameter, and those of the compressor 3½in., while the stroke is 5½in. When running at a speed of 1400 revolutions per minute the set will deliver 56 cubic feet of free air per minute, at a pressure of 115 lb. per square inch. The weight is some 880 lb., and the overall dimensions 51in. by 28in. by 47in.

The Carborundum Company, Limited, Trafford Park, Manchester, has a fine display of abrasives, among which one of the most noteworthy specimens is a large 40in. by 14in. carborundum wheel,

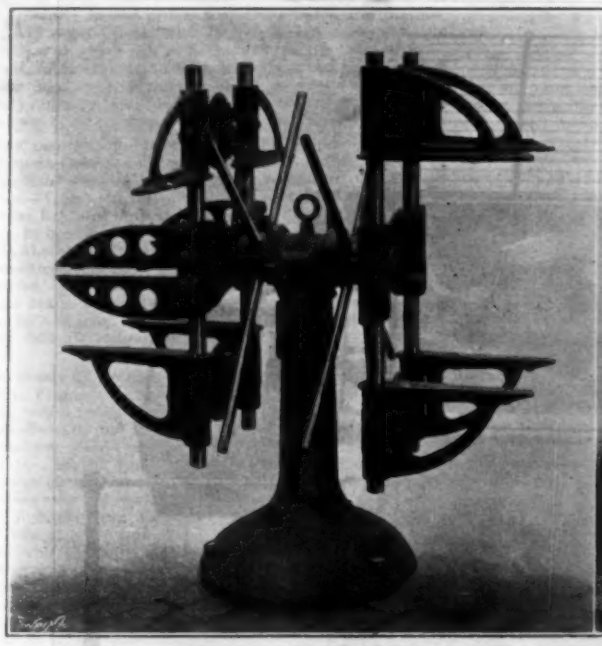


FIG. 11—DUPLEX ROLL-OVER MOULDING MACHINE

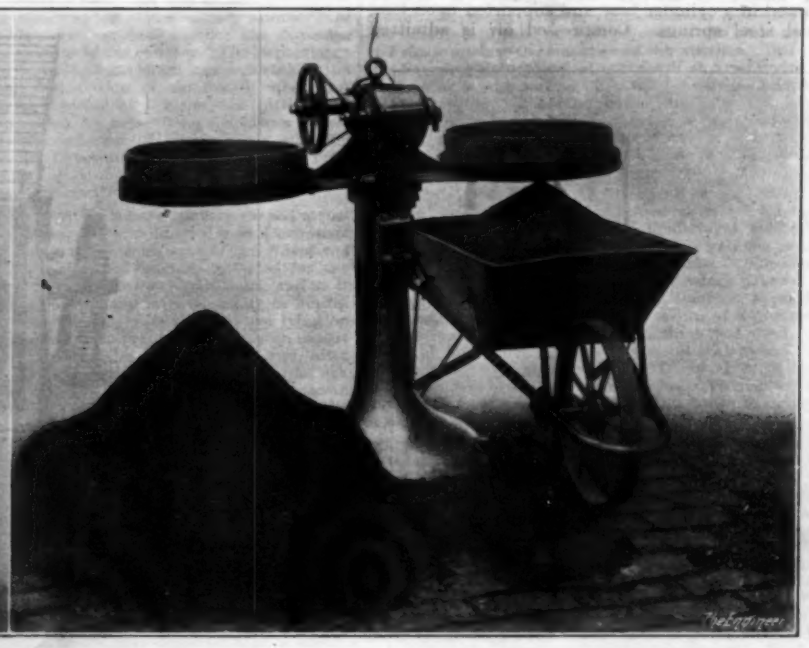


FIG. 12—DUPLEX SAND SIFTING MACHINE

intended for replacing the large wet grit stones used in many shops for dressing castings. One of these new wheels, we were told, will outlast eight 7ft. grit stones, while it is naturally much more easy to handle, being lighter, and if mounted properly will keep true throughout its life. The wheels are made in two thicknesses, cemented together, to ensure that the vitrification penetrates right through their thickness; but wheels up to 10in. wide can be made in one piece. On the same stand there are numerous examples of refractory bricks and slabs, the conductivity of which is said to be seven times greater than that of fire-brick, while they will withstand temperatures up to 1750 deg. Cent.

Macnab and Co., 56-58, Eagle-street, Southampton-row, London, W.C. 1, have a number of pneumatic, jar-ramming, moulding machines, largely of American manufacture, among which there are several examples of the Tabor "Shockless" jarring machine, which consists of a jarring table mounted upon an upstanding plunger forming the anvil. The plunger in turn is mounted in a cylinder base and supported upon long helical steel springs. Compressed air is admitted through an automatic valve, under hand control, and passes first into the jarring cylinder to raise the loaded table. At some predetermined point in the table movement the air is automatically cut off from the cylinder, and while the valve is reversing the confined air expands and lifts the table farther from its anvil. Then, when the operating valve completes its reverse movement the air from the jarring cylinder passes to the anvil cylinder beneath and the table drops by gravity. At the same time the plunger base or anvil is relieved of a considerable part of the load carried by its supporting springs, which immediately expand, and assisted by the air exhausted from the load lifting cylinder give the anvil an upward velocity to meet the falling table. The momentum of the rising anvil is substantially equal to that of the falling table at the instant of impact, and as a result both table and anvil come to rest with a powerful jarring or ramming effect upon the sand, but without shock or jar upon the foundation or any surrounding material.

Thwaites Brothers, Limited, Bradford, have a large stand, on which there are exhibited a complete cupola, a sand elevator, a sand mixer and sundry other items of foundry equipment. We hope to deal with the principal unit, the cupola and its charging mechanism, in our next issue.

There are among the exhibitors a number of firms showing the products of, rather than equipment for, foundries, and among these there may be mentioned the Shotts Iron Company, Limited, 1, Castle-street, Edinburgh, with a variety of large iron castings; Herring and Son, Limited, Chertsey, light and intricate castings in iron, aluminium; the Oak Foundry, Limited, Burnbrook, Birmingham, malleable castings; Andrew Handyside and Co., Limited, Derby, specimens of intricate cored castings in grey iron; the Consett Iron Company, Co. Durham, castings made from low-silicon pig; the Birtley Iron Company, Co. Durham, iron castings for turbine machinery and locomotives; N. Hingley and Sons, Limited, Netherton Ironworks, Dudley, pig and bar iron; Rudge Littley, Limited, Swan Village, West Bromwich, castings in steel alloy, iron, &c.; the Hoyt Metal Co. of Great Britain, Limited, Deodar-road, Putney, London, S.W. 15, anti-friction metals; and T. J. Priestman, Cupro Foundry, Leopold-street, Birmingham, non-ferrous alloys.

Several stands are devoted to minor supplies and stores for foundries, such as that of Nobel Industries, Limited, Nobel House, Buckingham-gate, London, S.W. 1, where there are samples of the Plastic Wood we recently described; the Amalgams Company, Limited, 186, Attercliffe-road, Sheffield, Sentinel pyrometers and Ferrum cements; J. W. and C. J. Phillips, 23, College-hill, Cannon-street, London, E.C. 4, white metal and brass letters, dowels, leather fillet, &c.; Major, Robinson and Co., Limited, Sykes-street, Manchester, tube bending machines; W. Canning and Co., Limited, Great Hampton-street, Birmingham, parting powder, scratch brushes, &c.; the Fordath Engineering Company, Limited, Hamblet Works, West Bromwich, core oil compounds; the Atlas Preservative Company, Limited, Windmill-lane Wharf, Deptford, paints, boiler preservatives, &c.; and Carbic Limited, 51, Holborn-viaduct, London, E.C. 1, acetylene welding and cutting equipments.

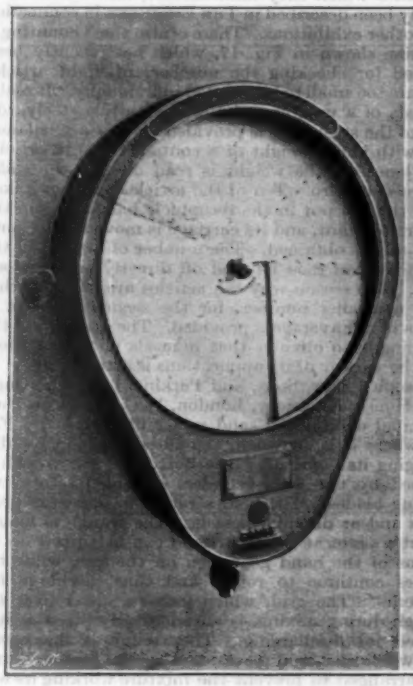


FIG. 14—PRESSURE RECORDER

FIG. 15—THERMOGRAPH

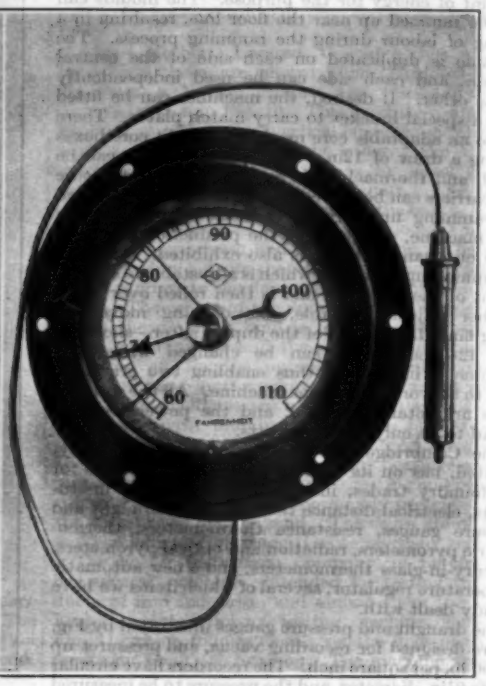



FIG. 16—DIAL THERMOMETER

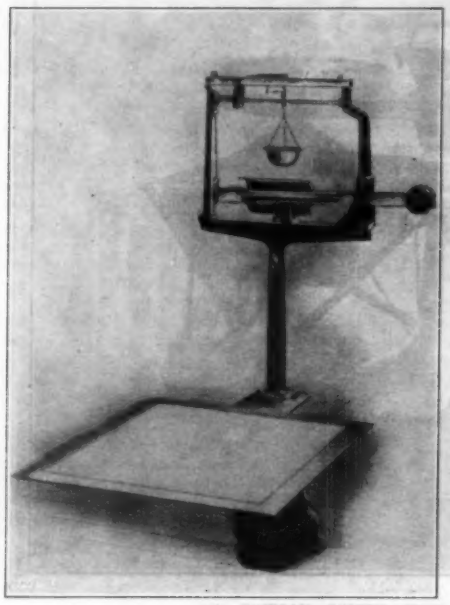


FIG. 17—"COUNTING" MACHINE

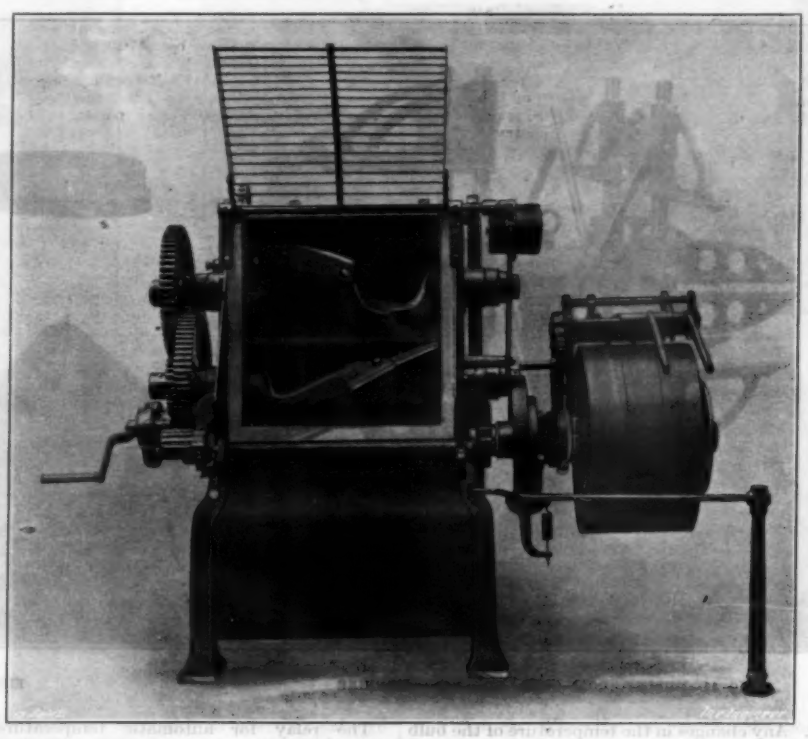


FIG. 18—SAND MIXER

## Railway Matters.

THE report of the Committee presided over by Colonel Pringle, which has been considering the question of automatic train control, has just been issued. We hope to deal with it in an early issue.

A PUBLIC notice has been given by the Burry Port and Gwendreath Valley Railway Company of a meeting of its shareholders to consider a scheme for its absorption by the Great Western Railway Company.

WHEN the Minister of Railways and Harbours introduced his Budget in the Union of South Africa Parliament, he said that the Natal electrification was only sanctioned after the scheme had been examined from every point of view, and that no other solution for the congestion was possible.

IT is the intention of the Canadian Government to send an exhibition train through France this year. An item of 50,000 dols. to cover the cost of the train has been approved by the House of Commons. Both agricultural and industrial exhibits will be shown, and it is expected that Canadian manufacturers will aid in fitting out and defraying the cost of the train.

THE Railroad Labour Board of the United States has ordered a reduction of about 12 to 13½ per cent. in the wages of the maintenance-of-way men. They now get from 28 to 40 cents per hour, and from July 1st, when the reduction takes effect, this will be from 23 to 35 cents per hour. About 400,000 men are concerned, and it is estimated that the savings will amount to 48,000,000 dols. a year.

DIFFERENCES of opinion having arisen between the American suppliers of timber and the railway users as to the sizes and grades of timber, a conference has been called by Mr. Herbert Hoover, the Secretary of Commerce. The suppliers complain that the railway companies insist on having certain sizes not in common use elsewhere, which cannot, therefore, be supplied from stock, but have to be cut specially. They also say that the manner in which the companies place their orders prevent the suppliers from using a tree to the best advantage.

A VERY important piece of work is about to be put in hand by the New York Central. This is to build a high-level bridge across the Hudson about 12 miles south of Albany, and a cut-off which will avoid that city. The bridge will have one span of 600ft., and another of 400ft., and have viaduct approaches, making a total length of about one mile. The total expenditure will be about 20,000,000 dols., and it is hoped that the whole work, including a large shunting yard and 20 miles of connections, will be finished within two years.

THE Municipal Council of Remiremont has passed a resolution asking for the construction of the Cornimont, Labresse, Metzeral tunnel, for which the Council has already voted 200,000f. It is pointed out that the tunnel will aid in the development of trade and industry by rendering communication between the two slopes of the Vosges far more rapid and the strategic advantages of the tunnel are also mentioned. The resolution calls upon the Minister of Public Works to obtain the consent of Parliament to the scheme, as being of public interest.

THE Department of Overseas Trade learns that a department called the "Centralne Biure Zakupow" has been established at the Polish Ministry for Railways, which will be entrusted with the purchase for the railways in Poland of all material necessary for their exploitation. At the present moment orders for rolling stock and bridges, &c., will not be dealt with by the new department, the activities of which will be limited to the purchase of rails, metals, lubricants, india-rubber goods, asbestos, glass, &c. It is understood that the proposal is to extend this department gradually, and for it to undertake subsequently the purchase of all the requirements of the Ministry.

THE mention by Mr. F. V. Russell, at the Institute of Transport Congress, of ashpits reminds us that the use of water-filled ashpits has become extensive in the United States. One such pit, 300ft. long and 14ft. wide at the bottom, has been built at Youngwood, on the Pennsylvania line. It has an engine track on each side, and each road holds three Mallet locomotives. An average of seventy locomotives per day are dealt with. The ashes are removed daily by means of a grab bucket handled by a steam crane. This work takes about four hours, and is done by one man. In the event of labour shortage or any other difficulty, the ashes need not be removed for four days.

IN nearly all the strikes and agitations amongst railwaymen in France the movement has originated in the workshops, where trouble has been fomented by a comparatively small element, and the majority of the railwaymen themselves have always been opposed to any interruption of the service. At the time of the last strike the Ouest-Etat railways decided upon closing down the repair shops and handing over the work to private firms. The Paris, Lyons and Mediterranean Railway Company has now decided to follow that example. One of its most important wagon repair shops is to be used as a locomotive depôt, and an arrangement for carrying out the repair work has been entered into with S.O.M.U.A., one of the subsidiary concerns of Messrs. Schneider et Cie., which will henceforth effect all wagon repairs for the P.L.M. Company at the works at Lyon-Vénissieux.

DURING shunting operations late in the evening of March 23rd last, three wagons were left on the down main line at Gogar, on the Edinburgh-Glasgow main line of the North British Railway, and forgotten by the goods guard and overlooked by the signalman. The latter accepted an express from Edinburgh, which ran into the wagons. The whole of the passenger train—five eight-wheeled bogie coaches—was derailed except the trailing wheels of the engine bogie. Major Mount's report on the accident has just been issued, the noteworthy point in which is that he said that track-circuit would safeguard failures of this kind, where signalmen overlooked vehicles on the main line, but in view of the close proximity of these movements to the signal-box this would not, as a general rule, be called for. We draw particular attention to this, as it is indicative that the Government inspectors do not make requirements that are unwarranted.

## Notes and Memoranda.

THE New South Wales gold yield for the first five months of 1922 amounted to 13,379 ounces (fine), valued at £56,029, as compared with 27,271 ounces, valued at £115,639, for the corresponding period last year.

A WRITER in the *American Machinist* suggests the use of rubber wedges for holding hammer heads on to their shafts. He puts several thicknesses of sheet rubber in the notch in the end of the shaft, squeezes it together in a vice, with about half an inch protruding above the jaws, and drives the head on. The rubber expands the split end of the shaft and, he says, entirely prevents the head coming off.

THE locks on the new Welland Ship Canal, tenders for which are being invited, will be the highest locks in the world, equalling an ascent of 139½ft. Each lock is 800ft. long, with 28ft. of water on sills. It is estimated that there are about four million cubic yards of rock and twenty-six million yards of earth to be excavated on this section, and about one million five hundred thousand cubic yards of concrete to be laid. The cost of the work is put at 30,000,000 dols.

THE value of the aluminium produced in the United States last year was 10,906,000 dols., while the 1920 output was worth 41,375,000 dols. This great decrease is attributed not only to a drop in the price of the metal but to the curtailment of its use in automobile industries. Imports of semi-manufactured aluminium in 1921 were 32,665,300 lb., compared with 39,298,650 lb. in 1920 while exports of aluminium in 1921 were 2,196,100 lb., as compared with 9,407,650 lb. in 1920.

A NOVEL method of overcoming the handicap imposed upon some hydro-electric plants by the rising of the tail-water level during floods was described to the American Society of Mechanical Engineers recently by Mr. J. A. Sirnit. He so arranges the flood overflow weir that a standing wave is produced on its downstream side and discharges the tail water from the turbines below the trough of the wave. In this way he is actually able to increase the available head during floods.

EXPERIMENTS carried out at the laboratory, and on a practical scale, on Hayling Island, have proved that the salt water mosquito, or rather its larvæ, can be exterminated by a liquid containing 15 per cent. of soluble cresol. Diluted to the extent of 1 in 16,000 it proved fatal to the larvæ in one hour, while it exterminated the pests in three and a-half hours at a strength of 1 in 48,000. Water treated in this way is said to be quite harmless to human beings or animals drinking it accidentally.

THE production of iron ore in France during the early part of this year amounted to 1,298,712 tons in January; 1,308,104 tons in February; 1,553,900 tons in March; and 1,379,721 tons in April. Stocks at the end of March showed a reduction compared with the January figure (3,911,401 tons against 4,190,272), and this decline continued in April, when the figure fell to 3,667,319 tons. During the same period the production of pig iron and steel was as follows:—January, 311,815 tons of pig iron, 314,598 tons of steel; February, 323,093 tons of pig iron, 316,705 tons of steel; March, 389,885 tons of pig iron, 366,951 tons of steel; April, 383,266 tons of pig iron, 324,330 tons of steel.

SOME months ago a scheme was devised for the establishment of a journal entirely devoted to the description of scientific instruments. A "preliminary number" of the publication has now been issued under the direction of the leading physicists of the country. The Department of Scientific and Industrial Research has undertaken the cost of issue and distribution of the first number, but unless scientific and technical persons and institutions show their appreciation by subscribing for future issues, the work cannot be continued. Hitherto many scientific instruments used for experimental work have never been described, and the object of this new journal is to place all future work of this kind on record.

THE launch of one of the most curiously-shaped structures ever put together on a building-slip at Devonport Dockyard, is described in a recent issue of the *Naval and Military Record*. It is a ship caisson, intended for use at the entrance to the basin at the North Yard, and as it was laid down on a covered slip, it was, owing to limitations of "head room," built on its side. When lying on the slip its appearance was so peculiar that only an expert could at first view distinguish deck from keel, and, after being put afloat, it resembled nothing more than an ark on her beam ends. About half an hour later the caisson had been brought into an upright position by filling the ballast tanks. The weight of the caisson is some 630 tons.

DESCRIBING to the Franklin Institute some experiments in under-water photography from aeroplanes, Colonel E. Lester Jones said that while photographs were made of the bottom through 30ft. or 40ft. of water, it was demonstrated that aerial photography was not a practical method to use, as the results were too uncertain. It is possible that, with further development of photographic methods and equipment, more positive results will be obtained. It would be a natural supposition to expect that shoal areas would show in sharp contrast to the surrounding deeper area, as the light rays travelled through different amounts of water. It was also expected that a shoal, being of different colour than the ocean bed in the immediate vicinity, would be plainly indicated. The results obtained were very confusing. Level bottom appeared as being dotted with shoals, which, upon investigation, proved to be due to vegetation growing on the bottom or else to vari-coloured bottom. Shoals, the positions and depths of which were known from surveys, could not be found in the photographs. The condition of the surface of the water seemed to affect the visibility of the under-water features, as did also light conditions. In fact, the limiting conditions necessary for good photographs, with the uncertain results, proved to be too strong an argument against aerial photo-hydrography. There seems to be a limited field of usefulness in the photography of possible channels in sedimentary rivers, or in shoal water bays, but even this will eliminate very little field work.

## Miscellanea.

THE address of the Mines Department of the Board of Trade will in future be Dean Stanley-street, Millbank, Westminster, S.W. 1.

AS a result of the growing activity of the port of Hamburg it is proposed to carry out improvements and extensions of the port, which will necessitate an expenditure of 138,000,000 marks.

FORTY-TWO merchant vessels totalling 217,220 tons were built in Japanese yards in 1921. These figures are almost half those for the previous year, when ninety-three ships of 433,000 tons were constructed.

TWO years ago the Bangor City Council received tenders for the repair of the pier severed by a steamer during a storm, and the lowest was £13,378. The Council decided to defer the work until prices dropped. It has now, according to the *Building News*, accepted a tender from a Halifax firm of £3684 for the work.

A COMPLETE survey of iron ore resources of British Columbia is to be commenced this summer. The Canadian Geological Survey Branch has agreed to undertake this important work in co-operation with the Provincial Department of Mines. The object is to obtain conclusive information as to the possibility of the province supporting a large-capacity iron and steel plant.

THE British Non-ferrous Metals Research Association, 71, Temple-row, Birmingham, has carried out an extensive research on the influence of gases on high-grade brass. A further investigation is now being started by the Association at the Research Department, Woolwich, in which the support of the Engineering Co-ordinating Board of the Department of Scientific and Industrial Research has been secured. The prime object of the present work is to study the conditions necessary for securing both surface and internal soundness of strip brass ingots such as are required for cold-rolled sheet metal.

THERE was a decrease of over 4,746,000 tons in the output of coal from India during 1920. This decrease was due largely to Bengal and Bihar and Orissa; Assam showed a distinct increase. There was a general increase in the pit's mouth value everywhere, except in Assam. The recent discovery of two unexposed seams of good steam coal in the Talchir coalfield, the possibility of which was foreseen by Blanford in 1872, may do something to alleviate the present congestion of coal transport. Exports of coal rose from 507,930 tons in 1919 to 1,228,408 in 1920. Imports, on the other hand, fell from 48,675 tons to 39,727 tons.

AMONG the various recommendations of the Sheffield Committee on Smoke Abatement there is the following:—"We cordially support the recommendation that justices should be empowered to impose larger fines than at present. This is an urgent requirement if local authorities are to be enabled to carry out their duties in respect of smoke prevention. The fireman should be liable to be fined if he fails to show that the means provided had not been negligently used. We are in favour generally of the Committee's recommendations that the Act should be extended so as to apply to all manufactures from which noxious vapours might come."

WIRELESS telephony is being pressed into the service of agriculture in France. At the Council of Ministers held at the Elysée on Tuesday morning, June 20th, the Air Minister, M. Laurent-Eynac, and the Minister of Agriculture, M. Henry Chéron, communicated measures they have decided to take in order to protect the rural regions of France against the surprises of the weather. In future the National Meteorological Office will at fixed hours and twice daily send a weather forecast by wireless telephone to each region. The Communes will have a receiving station put up in the parish school or at the gendarmerie station, and they will warn the peasants of impending storms by ringing a bell. The cost of the receiving stations will only be 200f. (£4).

ON Tuesday last Mr. N. W. Prangnell gave a lecture and demonstration before the Hull Association of Engineers on the subject of "The Laval Centrifugal Method of Purifying Lubricating and Electrical Oils and the Separation of Liquids of Varying Specific Gravity." The lecture was illustrated by a number of slides, which covered the theory of separation by centrifugal force as applied to these machines, and pictures were shown of a number of installations. A small-capacity machine was used for a practical demonstration, and some oil which had been contaminated by the addition of 50 per cent. of water and a quantity of sand and graphite, after passing through the machine, was found to contain no traces of moisture or other foreign matter.

IT is stated in the *South African Mining and Engineering Journal* that the foundations for the 42,000 tons terminal grain elevator at Durban, bringing the work up to the ground level, are about half completed and the subsidiary work is well under weigh. At Capetown difficulties have been encountered in connection with the only suitable site for the 30,000 tons terminal elevator, which has delayed construction, but it is anticipated these will be surmounted and work commenced at no distant date. A start has been made in the construction of group elevators in the Free State, and further groups in the Transvaal will also be under weigh very soon. The work is being pushed forward with the utmost energy both by the Railway Administration and the contractors.

ILEBO, a point on the Kasai River some 30 kiloms. south of the confluence with the Sankuru, has been chosen as the terminal port of the Congo-Katanga Railway, Central Africa. Ilebo can be reached all the year round by boats of 500 tons, whereas at Djoko-Punda at certain times of the year it is impossible to navigate with small boats of only 25 tons. At Ilebo 800 m. of deep water wharves can be built. From the Katanga end the terminal port will be Bukama and not Sankishia, as originally intended. Bukama is the junction of the Katanga Railway and Grand Lacs Company systems. The laying out of the new line will be commenced immediately, and it is estimated that the constructional work will take six years. It will thus be finished at about the same time as the new plant of the Union Minere is expected to commence production.

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(*For description see page* 686)

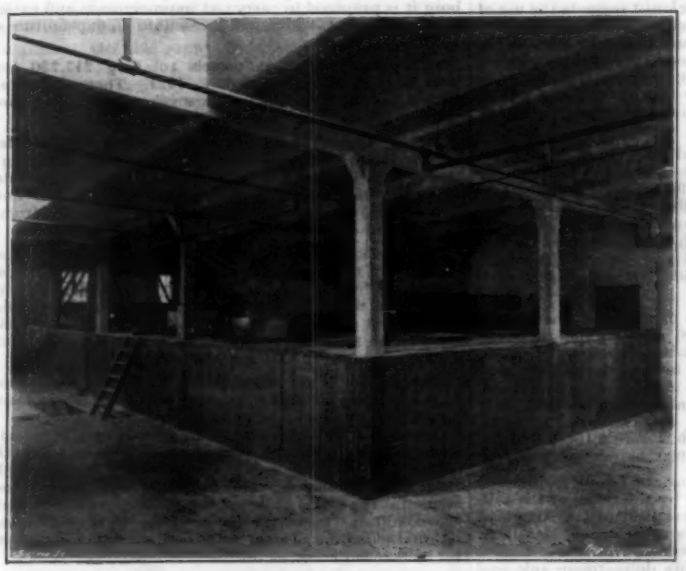

FIG. 35—BULK FLOUR STORAGE BINS

FIG. 36—BIN DISCHARGERS BELOW BULK BINS

FIG. 37—SACKING-OFF FLOOR

FIG. 38—THE LABORATORY

FIG. 39—THE ENGINEERS' SHOP

FIG. 40—THE JOINERS' SHOP

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## Contents.


THE ENGINEER, June 23rd, 1922. PAGE

DEVELOPMENTS IN POWER STATION DESIGN. No. XXXIV. (Illus.) .. .. .. .. .. .. 683
INSTITUTION OF MECHANICAL ENGINEERS. No. I. .. .. .. .. 685
A MODERN FLOUR MILL. No. IV. (Illus.) .. .. .. .. .. 686
ELECTRIC PRODUCTION OF PHOSPHORIC ACID .. .. .. .. 688
THE CANADIAN-PACIFIC LINER EMPRESS OF AUSTRALIA. (Illus.) 689

LETTERS TO THE EDITOR—
Avoidable Waste in Locomotive Operation .. .. .. .. .. 690
A Cause of Unemployment .. .. .. .. .. .. .. 690
The Cause of Trade Cycles .. .. .. .. .. .. .. 690
British Evaporation Unit .. .. .. .. .. .. .. 690

A SEVEN-DAY JOURNAL .. .. .. .. .. .. .. .. 691
THE FOUNDRY TRADES EXHIBITION. No. II. (Illus.) .. .. 692
RAILWAY MATTERS .. .. .. .. .. .. .. .. .. 695
NOTES AND MEMORANDA .. .. .. .. .. .. .. .. 695
MISCELLANEA .. .. .. .. .. .. .. .. .. .. 695

LEADING ARTICLES—
The Failure of Civil Aviation .. .. .. .. .. .. .. 697
American Research in Metal Welding .. .. .. .. .. 698

THE EAST HORNDON LOCOMOTIVE FAILURE .. .. .. .. 698
THE BRITISH FINE CHEMICAL INDUSTRY .. .. .. .. .. 699
BOOKS RECEIVED .. .. .. .. .. .. .. .. .. 699
A NEW HIGH-SPEED FELLOWS GEAR SHAPER. (Illus.) .. .. .. 700
ELECTRIC LOCOMOTIVES. (Illus.) .. .. .. .. .. .. 701
COAL MINING IN THE FEDERATED MALAY STATES .. .. .. 704
OIL IN NEW GUINEA .. .. .. .. .. .. .. .. .. 704
PETROL FIRE AT BOMBAY .. .. .. .. .. .. .. .. 704
AUTOMATIC SUB-STATIONS .. .. .. .. .. .. .. .. 704
CATALOGUES .. .. .. .. .. .. .. .. .. .. 704

PROVINCIAL LETTERS—
The Midlands and Staffordshire .. .. .. .. .. .. .. 705
Lancashire .. .. .. .. .. .. .. .. .. .. .. 705
Sheffield .. .. .. .. .. .. .. .. .. .. .. 706
North of England .. .. .. .. .. .. .. .. .. 706
Scotland .. .. .. .. .. .. .. .. .. .. .. 707
Wales and Adjoining Counties .. .. .. .. .. .. .. 707

CURRENT PRICES FOR METALS AND FUELS .. .. .. .. .. 708
FRENCH ENGINEERING NOTES .. .. .. .. .. .. .. 709
BRITISH PATENT SPECIFICATIONS. (Illus.) .. .. .. .. .. 709
PERSONAL AND BUSINESS ARRANGEMENTS .. .. .. .. .. 710
FORTHCOMING ENGAGEMENTS .. .. .. .. .. .. .. 710
LAUNCHES AND TRIAL TRIPS .. .. .. .. .. .. .. 710

PARAGRAPHS—
Contracts .. .. .. .. .. .. .. .. .. .. .. 710
Society of Chemical Industry .. .. .. .. .. .. .. 710



# THE ENGINEER.

*JUNE* 23, 1922.


### The Failure of Civil Aviation.

IN spite of various efforts to disguise the fact, it is abundantly clear that civil aviation and the aeronautical industry are languishing to an extent and at a rate which threatens their early extinction. On the one hand, we have such signs as that contained in the announcement that one of our largest and best-known aeroplane building firms intends to call a meeting of its shareholders with a view to deciding whether to continue or wind up its operations. On the other, we meet daily with fresh evidence that the transport of passengers and goods by air has failed to receive that measure of public support which, even with the benefit of liberal subsidies from the Government, is required for its commercial success. Two years ago there were 240 civil machines in this country licensed by the Air Ministry as air-worthy. A year ago the number was 137. At the beginning of this month it had fallen to 97. Again, the seating accommodation available on the London-Paris air route is now three times as great as it was a year ago, yet the number of passengers being carried has remained stationary, and during the first fortnight of this month showed a considerable decrease as compared with the same period last year. Fresh routes, it is true, are to be opened up, such as that proposed between Southampton and Cherbourg. Occasionally, too, we hear of new machines being built for the existing commercial services. It would be wrong, however, to interpret either fact as implying an increase in the popularity of aerial transport. Services may be planned and machines provided to operate them in the hope, rather than the certainty, that traffic in sufficient volume to make them pay will be forthcoming. The situation is a serious one from the national point of view, for our announced policy is to depend upon civil aviation as a reserve both for machines and men to meet the needs of the Royal Air Force in the event of a call for sudden expansion.

Were it not for the national aspect of the matter we should hardly feel called upon to write much at this date regarding the virtual failure of civil aviation as a commercial undertaking, for all that we could say on this subject we said several years ago. As it is, the fact has to be faced that civil aviation has completely falsified those expectations which alone would justify the expenditure of public money upon it by way of subsidy. It is neither serving to keep the aeronautical industry in being nor showing itself in any way capable of providing a reserve to the military branch. Of the 97 aeroplanes which, as we have said, were certified, as on the first of this month, to be air-worthy, 83, it is officially recorded, were of "some value" for war purposes, including training. From the military point of view, however, their value is considerably depreciated by the fact that they comprise no less than twenty-eight different types. To this extent and no more is civil aviation providing a reserve of machines. It is clear that to maintain the civil aerial fleet at its present standard not more than one medium-sized factory would be required. Indeed, it may be accepted as true that whatever activity prevails at present in the aeronautical industry springs almost entirely from the fulfilment of Government orders for military aircraft, and that had the industry to depend on the supply of civil machines, otherwise than by way of a side line of the most modest dimensions, the factories yet remaining open would long ago have ceased operations. To what extent civil aviation is providing a reserve of *personnel* it is perhaps a little difficult to say, but if we may judge from the significant fact that the Air Ministry has been reduced to advertising for candidates for flying commissions we should say that civil aviation is as completely a failure in this respect as in the others. It is a costly failure, and as time goes on it will become still more costly. To the gross earnings of every approved company operating a commercial air service the Government adds, by way of subsidy, a sum equal to 25 per cent. of such earnings. In addition, for every passenger carried on the London-Paris route it gives the company £3, and for every pound of goods, 3d. It also bears a large share in the insurance of the machines, provides weather reports, wireless direction finding, and other services free of charge, and supplies the companies with machines on a financially ruinous hire-purchase system. The total annual cost to the nation of civil aviation, as at present conducted, cannot be far short of, and, indeed, probably exceeds, the £200,000 which the Air Ministry is authorised to expend on the two items, the payment of the subsidies and the provision of machines. For that sum the nation in return is receiving the promise of a reinforcement of eighty-three machines "of some military value" in its hour of need, and, we presume, of the services of the pilots and ground staff necessary to their operation. For each such reserve machine, with its *personnel*, the nation is paying at the rate of at least £2400 per annum. That sum would be sufficient to pay for the construction of a modern military machine of average size and to store it for a year.

As a means, then, of providing the necessary reserve of machines, civil aviation at present is hopelessly inefficient and costly, and we are convinced that under no likely circumstances in the near future will it become profitable to the nation. From the very earliest we have held the view, and expressed it, that aeronautics is primarily and almost entirely a military subject, and the present condition of civil aviation, after three years of efforts to bolster it up, convinces us, if we needed conviction, that that view is sound. We have thus to face the fact that we are relying for an important national service upon the reserves provided by a scheme which, to all who wish to see, is inefficient, ill-advised, and insecure. The encouragement of civil aviation is not the only means of securing the national requirement of aerial reserves. It seemed at one time the most obvious and practical, and as such was advanced and adopted, no doubt in good faith. It has now been proved to be extravagantly impracticable, and calls for deletion. In its place it is to-day not ridiculous to suggest that we should build military machines and store them for the bigger part of their lives. The experience of the Aircraft Disposal Company since it took over the Government's surplus war machines, many of which it has still in its possession, teaches us that aeroplanes, their componenta and engines can be satisfactorily and economically stored without sensible deterioration for much longer periods than was believed possible a few years ago. By adopting a programme of building and storing we would at least be assured of a reserve of machines of something more than "some military value," would keep the aircraft factories in good trim for a military demand upon them to increase their output, and would not commit ourselves to much, or any, greater expense than is at present being incurred annually in the "encouragement" of civil aviation. Such a scheme would not, of course, automatically produce a reserve of operating *personnel*. But neither does civil aviation at present to anything like the necessary extent, so that in any event the question of providing reserve pilots and mechanics demands immediate consideration. It is to be sincerely hoped that in the endeavour to solve this problem some other means than the subsidising of civil aviation may be found, and that those responsible for settling the nation's policy will recognise

that the means of providing reserve *personnel* and reserve equipment on the most economical and efficient basis are not necessarily to be found in one and the same solution.

### American Research in Metal Welding.

AN interesting example of modern methods of technical research conducted under scientific conditions on a comprehensive plan, with the direct aim of benefiting a particular industry, is the work now being carried out by the American Bureau of Welding. A recent bulletin issued by this organisation points out that there is an enormous field for the further application of welding, but that progress is delayed by incomplete knowledge and by the opposing claims of competitive interests. The opportunity for the wider use of welding lies, it is pointed out, in two directions. First, for ordinary work in which the weld does not carry the main burden of the structure, and, secondly, for joints that become the strength-members of a structure, and must, therefore, be subject to calculation. Welding has been applied successfully to important work of the latter class, as well as to a variety of work of the former class. It was to provide united and co-operative action in extending the knowledge of the art of welding and enlarging its field of industrial application that the American Welding Society was organised, and it acts as a clearing house for information. It was found, however, that to place the welding industry on a sound foundation, an immense amount of work was required, and it became evident that that work could only be done effectively and economically and within reasonable time by the active co-operation of all parties interested. With a view to bringing about such co-ordination of effort, the American Welding Society and the engineering division of the National Research Council organised an Advisory Committee of Research and Standardisation, and it is that Committee which is known as the American Bureau of Welding. It is composed of twelve members appointed by the American Welding Society, two members from each local Chapter of that Society, and one member from each of about twenty-five engineering and scientific societies and Government offices.

In order to carry out the more effectively the work which it was appointed to perform, the Bureau proceeded to elect eleven committees each charged with the investigation of a particular branch of the subject. The first committee is, for instance, dealing with the question of arc welding, and some of the problems to which it is particularly directing its attention are—(*a*) the proper strengths and type of current under various conditions; (*b*) the size and composition of electrodes best suited for different thicknesses of plates and different grades of steel and cast iron; (*c*) the physics of the transference of the metal across the arc; and (*d*) the preparation of welding edges. Among the subjects being specially studied by the second committee, which is investigating gas welding, are the different styles of joints and angles of bevel; the sizes of nozzles best adapted for various conditions; expansion, contraction, pre-heating, &c. The third committee is examining electric resistance welding in all its branches, and is particularly taking into consideration such variables as time, current, pressure, and methods of clamping, especially as to parts which have different specific heats and melting points. The fourth committee—which is devoting its attention to Thermit welding—is inquiring specially into the question of the prevention of blow-holes, and has, it is understood, met with a considerable amount of success. To other committees have been allotted such subjects as "Standard Tests for Welds"; "Welding Wire Specifications"; "The Training of Welding Operators"; "Specifications for Steel to be Welded"; "Welding Storage Tanks"; and "Welded Rail Joints"; and, finally, there is a committee the duty of which appears to be to confer on the subject of welding generally with other bodies. It is, for example, at present working with the Boiler Code Committee of the American Society of Mechanical Engineers in drawing up regulations regarding the use of welding in the construction of vessels designed to carry pressure. It is hoped, in this direction, to demonstrate so fully the safety of welding for such purposes that the existing restrictions imposed on its use by the Boiler Code Committee may be removed, or, at any rate, considerably relaxed.

A great deal of benefit is expected to result from the activities of the Bureau and its various committees, and there is good reason for believing that the expectation will be realised. There are many points in connection with the various methods of welding now in existence on which there is still no definite agreement as to the best methods of procedure, and it is by no means unusual for experts to recommend entirely opposed lines of action even in cases in which no commercial competition is concerned. It would be curious, in fact, if there were general agreement on all points, seeing how much of the development which has taken place in various directions was due to progress made under the stress of war demands when it was a question of getting things done somehow in the best available way and when there was no time to consult others as to what their experiences had been. When failures were experienced, their causes in many cases remained unknown. The new body will apparently concern itself with such matters, and by scientific research endeavour to find remedies for the troubles and difficulties encountered in the past or to be met with in the future. Already, we gather, the Bureau is beginning to supply the need for an independent and unbiassed authority regarding certain questions which have arisen along various lines, such as regulatory and safety legislation; the training of welders; the technique of welding and the principles involved. To determine fundamental scientific facts and to reduce the art of welding to a sound and scientific basis are the chief functions of the Bureau, and in pursuance of these objects it has instructed its various committees to prepare critical summaries of the knowledge existing in their respective spheres. These summaries will give to the industry concise statements of the best information at present available, and it is anticipated that they will be of considerable value. Particularly good results are anticipated from the labours of the Standard Tests Committee, and from the bulletin which the Training of Operators Committee is about to issue and which has been prepared after a careful comparison of the different methods employed in a number of schools, railways, shipyards and engineering works. The Bureau is perfectly correct in its statement that there is a very wide field for the further application of welding, and it would certainly be to the advantage of everyone if advances made were in every case along the best possible lines.

## The East Horndon Locomotive Failure.

ON the afternoon of January 11th last, as the Midland Company's 2.45 p.m. passenger train from St. Pancras to Southend, drawn by engine No. 44 of the 2-4-0 type, was about a mile in the rear of East Horndon Station, the little end strap of the right-hand connecting-rod was fractured. The rod was also broken in three places, and the piece remaining attached to the big end pierced the fire-box, causing the escape of steam and water on to the footplate. The driver, Kemp, was killed instantly, and his fireman, Angell, received very serious injuries. The latter has, however, had a remarkable recovery, and is making satisfactory, though slow, progress. He was able to be seen on April 11th by Major Mount, of the Ministry of Transport, whose report on the accident was issued on the 15th inst. The train came to a stand in a distance of about 500 yards from the point where the failure probably occurred. The regulator was found in the closed position, the reversing handle in full forward gear, and the brake handle in the applied position. The engine was built in 1870, since which time it has run 1,382,808 miles. It left the shops on October 30th, 1918, when it received a new boiler and was thoroughly overhauled, and has since run 55,984 miles. The three pieces of connecting-rod were found in the following positions:—Piece 18in. long, 480 yards from the distant signal; piece 5in. long, 283 yards from the distant,; butt end of connecting-rod, bent double, 79 yards from the distant. The speed was about 30 miles per hour, and the load, exclusive of engine and tender, was 152 tons. The gradient approaching the scene of the accident falls, on an average, 1 in 250, and is then level.

We have not space to deal with the result of the failure, but only its cause, so we will proceed to quote the following from the evidence given by Sir Henry Fowler:—"In overhauling an engine, special examination is made for flaws in the big and little ends of the connecting-rods, and if there is any sign of the slightest flaw the part is scrapped. The parts are examined visually and struck with a hammer, so that if there is any incipient flaw, oil will ooze out and leave a black streak. We cannot say if the connecting-rods on this engine are those originally provided when the engine was built. The rods were not renewed when the engine was rebuilt in 1918. Unfortunately, a large number of our records were destroyed between 1905 and 1909, so we have no record of previous rod renewals. This is an iron rod, but we cannot say when it was put in. We commenced to adopt steel rods about 1884 to 1886, but I cannot say if we continued purchasing iron rods after this date; in fact, we have no record as to the age of this rod.

"Having regard to the speed, viz., 42 miles an hour average, though the train was probably running faster than this, I think the engine was suitable for its work. I am speaking without knowing the weight of the train. I have worked out the stresses in the rod, and when starting the stress on the smallest section is 3.872 tons per square inch. At a speed of about 50 miles an hour and a mean pressure in the cylinder of 50 lb., the stress at the middle of the rod would be 1.84 tons. The boiler pressure is 160 lb. to the square inch, and I have taken 50 lb. as the mean effective pressure at 50 miles an hour. At starting I have assumed an effective pressure on the piston of 160 lb. In present-day design this may be looked upon as satisfactory. I have had little experience in broken connecting-rods; in fact, this is a very rare occurrence. I have no recollection in twenty-one years' experience on the Midland Railway of a connecting-rod puncturing a boiler.

"I suggest that the cause of the accident was due to the breaking of the little end strap, the pulling of the strap over the gudgeon pin of the crosshead, this being followed by the breaking of the connecting-rod at its smallest section near the little end. This was followed by a piece about 18in. long breaking off, the shortened connecting-rod then burst through the fire-box just about the foundation ring. At this time the 5in. portion of the connecting-rod was broken off, and the remainder slid up the fire-box, encountered the stretcher plate, and was forced through the boiler just at the back of the brick arch, which was destroyed in consequence. Then, in a manner of which I am not perfectly clear, the portion of the connecting-rod still attached to the big end strap was bent over laterally and towards the framing of the engine. It was also torn out of the big end strap. This could only happen when the big end was clear of the crank cheeks. The portion of the connecting-rod between the second bolt and the end is burst, one side being turned round at right angles and the first bolt being sheared, the other bolt and the cotter and brass being left in position on the crank pin."

Mr. Geach, the motive power superintendent, stated:—"The connecting-rod of an engine comes under periodical examination based upon the mileage performed. There are different mileages for examination of the various parts, and certain mileage limits laid down to define the period of thorough examination. The mileage in the case of the connecting-rods of this engine is 5000 to 6000 miles. This embraces big and little ends, crank journals, connecting-rods, and outside coupling-rods. The examination made of the parts mentioned consists of taking down, thorough cleaning, visual examinations, and the impact or hammer test that Sir Henry Fowler spoke about, to show whether there is any flaw extending to the surface. This examination was carried out by fitter Davis, of Shoeburyness, at the running shed at Tilbury on November 8th, 1921. During this examination any work required is carried out, and parts replaced if necessary.

"The little end strap must have pulled over the gudgeon pin. Having done that, the whole rod is then free, connected only at one end to the big end on the crank. As to how the mark of the cotter comes on the spectacle framing, it must presumably have been caused by the little end dropping down into the lower radius of the aperture in the spectacle frame, with the cotter outside the spectacle frame. When the cotter hit the spectacle plate, the assumption is that it then jammed, and the first fracture occurred in the small end of the rod. When the second portion of the rod was broken off by contact with some portion of the engine or the sleepers—the rod being free to swing centrifugally to the axle—it is possible that the big end became jammed, leaving the remainder of the rod fixed in position to perforate the fire-box. I account for the second fracture of the rod, i.e., the long portion, by contact with the ground or some object. The connecting-rod was then in a fixed position in which, as it went round with the crank, the remaining portion was driven right through the outer shell and inner fire-box, so breaking off the shorter or third piece. Presumably, on pulling out again, the big end and the remaining portion of the rod must have been still so fixed on the crank, so that in striking the stretcher plate between the frames, it was diverted into the boiler at an angle, causing the second perforation. I think this was done by one rotation of the axle. It is difficult to account for the grooving between the two punctures in the fire-box, but I can only think each puncture and the grooving all occurred in the one rotation of the wheel. After drawing out from the second puncture, the connecting-rod must have met some obstruction—what, I cannot say—sufficient to bend it completely round towards the frame and wrench it out from the strap. I think if this puncture had taken place in two or three revolutions of the driving wheel, the damage to the fire-box would have been more extensive.

"I cannot recollect a case of a broken connecting-rod in my experience, but from time to time cases have occurred of little end straps failing. I agree with the stresses mentioned by Sir Henry Fowler. Awards are made to men who, outside their ordinary work, observe and report defects. A cleaner, for instance, would be rewarded if he detected a defect while cleaning. In 1918 this engine had a new boiler and the return to shops for overhauling depends upon the results of the periodical examination of the fire-box and boiler. The axle-boxes on engine No. 44 are not fitted with adjusting wedges, nor have the company any engines so fitted on the main line."

Sir Henry Fowler has been able to obtain evidence to show that the rod originally put into this engine had a rectangular hole in the butt; and that about twenty-seven years ago the practice of fitting rods with round holes, similar to that under reference, was first adopted. It would appear therefore that the rod could not have been older than this. The little end strap is likewise of a later design than the type fitted at the time this engine was built, and it is thought that it also was not older than twenty-seven years.

With regard to the stresses in the rod mentioned by Sir Henry Fowler, the subsequent tests showed a minimum breaking stress of 23.1 tons per square inch, and therefore a calculated factor of safety of 6 was provided for when starting. In respect of the little end strap, the corresponding calculated stress in each fork was about 2.4 tons per square inch, which allows for a factor of safety of over 9 on the results of the subsequent tests, which showed a minimum breaking stress of 22.5 tons per square inch. The last periodical inspection was conducted by fitter Davis at Tilbury on November 8th, 1921, when no defect was observed. The previous examination, which was also satisfactory, had been carried out by fitter Calistan on May 31st, 1921, and between these dates, the engine

had run 5841 miles with only one minor report, on September 30th, 1921, in respect of the right-hand big end cotter set screw. In making the last examination, Davis stated that he remembered the case. He took down the four big and little ends and conducted the usual tests of striking the prongs of the strap with a lead hammer, and examined for flaws with a lamp. In his twenty-five years' experience, he has spent nine years on this particular type of examination.

Subsequent to this examination, the engine was reported on December 30th, 1921, for big and little ends knocking. Driver Harris, a man of long experience, stated that Kemp, knowing engine No. 44 had to be washed out, took the opportunity of making this report, which Harris rendered at Plaistow after exchanging engines with Kemp. Harris drove engine No. 44 for three miles from Barking to Plaistow, and though he said that the knock warranted repair, he did not consider it excessive.

Fitter Calistan dealt with this repair at Plaistow on the 31st. The big ends had sufficient draw on them and they were therefore cottered down. The wear was, it is understood, not excessive. Both small end brasses, however, were reduced, refitted and lined up. The time shown by Calistan for the work was 4 h. 5 min., which is about the normal time for dealing with a repair of this kind. He has had considerable experience in this class of work abroad, but has only recently joined the Midland Railway at Plaistow, where he is the junior fitter, and responsible for connecting-rod examinations. He found nothing to cause suspicion during this examination, and since this repair up to the time of the accident the engine ran 650 miles.

After this, however, the engine was reported again on January 3rd, eight days before the accident, in respect of the right-hand small-end cotter working upwards, causing its split pin to shear off. Fitter Davis dealt with this small defect by knocking the cotter down and renewing the split pin. He stated that the occurrence was unusual, though he had experienced it before on other engines, and it had no significance to him. It was the last defect reported, and dealt with, prior to the accident so far as this part of the motion is concerned.

On April 11th Major Mount questioned fireman Angell at the hospital, and though still far from well, he was able to give evidence of value in this case. He had not heard Kemp complain of this engine, though he—Angell—referred to it as a "rough" engine, and said, in illustration of his meaning, that "the draw-pin kept coming up." Kemp, however, had not thought it necessary to report this. In this connection, he referred in the following words to the failure of a driving axle spring: "When we were coming from Southend the driving spring broke, and we had it booked. The next day it was in the same condition; my mate reported it again on the next day, and it was still in the same condition, so we wired Kentish Town to say we were bringing this engine to have the spring changed."

On the driving axles of these engines there are two outside upper springs and two inside lower springs. Angell referred to the latter and said that the bottom plate of each spring could be moved by hand. He remembered the knock reported by Kemp in the big and little ends on December 30th, but he thought that this took place before the spring failure, and that both these repairs were carried out at Kentish Town at the same time. With regard to repairs generally, he said that, with the exception of these springs, no trouble had been experienced in respect of reported repairs not receiving attention.

Reference to the repair cards generally confirms Angell's evidence, and shows that one spring was first reported, presumably at Shoeburyness, by driver Davey on December 16th; that both were reported on December 18th by driver Watts; and that it was not until Kemp's report on December 19th at Kentish Town that the engine was stopped by Mr. Gair, the foreman fitter, when new springs were fitted on the 20th. The cards of December 16th and 18th are blank, and therefore do not disclose what, if any, action was taken.

In connection with this repair, Mr. Gair stated that it was only on this occasion that Engine No. 44 had been attended to at Kentish Town. Kemp had reported the failure of both driving springs, the looseness of the left tender brake shaft, and other defects of a minor character. Nothing was reported in connection with big or little ends, and no work was done upon them. In fact, as already related, trouble in this respect was not experienced until ten days later. Mr. Gair stated that as far as he could remember, three or four leaves in each spring had broken at the buckle. Questioned, however, in respect of failure or looseness of a bottom plate only, he said that he would let an engine run and keep a careful watch on the spring. He emphatically repudiated the suggestion that defects which has been reported by drivers, and which were likely, in his opinion, to be detrimental to safe running, were not carried out when reported.

Mr. Talbot, the district locomotive superintendent at Kentish Town, also gave evidence as to the system of running on the St. Pancras–Shoeburyness service, and in respect of the card system of booking repairs. He explained that though the repairs of December 20th were carried out at Kentish Town, the card was subsequently sent to Shoeburyness, the headquarters of engine No. 44, in order to complete its record in this respect.

Major Mount agreed with the opinion expressed by the company's representatives that the immediate cause of this accident was the fracture of the little end strap. There were signs of a concealed flaw on the inside of the bend at the top of the strap just clear of the radius, and undoubtedly this weakness accounted for the failure at this point.

It seems incredible that Kemp, he thinks, could have remained at his post after the first penetration occurred, but he may have been rather more protected in his position on the right-hand side of the fire door than his fireman. Though Angell did not observe more than the closing of the regulator, it is clear that Kemp was able to apply the brake and return the reversing handle to full forward gear. At 35 miles an hour, it is unlikely that he had more than 10 sec. to 15 sec. in which to act, and whether he applied the brake unnoticed by Angell before the first rush of steam, or immediately afterwards, he deserves much credit. He may have been bending down listening to the noise, for I understand that his injuries were consistent with a heavy blow on the forehead by a piece of fire-bar or brick projected through the fire door.

Both men were helpless so far as their own safety was concerned, and with regard to the circumstances of the failure are clearly free from all blame. They were stationed at Kentish Town, and Mr. Talbot and Mr. Notley, the locomotive foreman, spoke very highly of them. Mr. Notley had known Kemp for thirty years and referred to him as "one of the best men we ever had on the footplate."

Major Mount then discusses the question of inspection and closes his remarks thereon by observing that he is satisfied that no defect was noticeable, and it would appear that, in seeking for the primary cause of this failure, carelessness or lack of examination on the part of the inspection and repair staff can be eliminated.

"It does not, however, follow," he continues, "that certain internal discontinuity in the material did not on this date exist. Some inherent weakness may have recently caused this point to become unduly stressed, with the result that the flaw extended, ending in complete failure. It is unlikely that this state of affairs could have been going on for any long period, and it is therefore to any recent rough usage, which might have led to the development of the flaw, that the company's attention should be drawn.

"The engine was not unfitted for its work. The calculated factor of safety of the connecting-rod was about 6, and that of the little end strap as high as 9. These figures, however, would not cover irregular stresses due to forces which are not easily calculable, such as those induced by the presence of water in the cylinders or by irregularities in the road, bad springs, &c. In regard to the former, there is Angell's evidence that, in spite of the water at Shoeburyness, which admittedly tends to priming, engine No. 44 was a good steamer and gave little or no trouble in this respect. As the result of the latter, however, high stresses may be set up, particularly if the driving axle receives a jolt when the crank is at its lowest point. Angell's evidence, therefore, in regard to the failure of the driving springs, which were reported on December 16th, and were not replaced till December 20th, is of importance. Whether this played any part in seriously enlarging the flaw, it is impossible to say; but the circumstances are significant. It must, however, be borne in mind that since this repair the engine ran for 1185 miles, during which time the strap came under inspection. I have accordingly come to the conclusion that the fracture arose through a cause which was not readily discernible."

With regard to the material of the strap—wrought iron—it was of high grade, similar to that in use in about one-third of the engines on the system. The tests disclosed no abnormal features and the surfaces of the fracture, in spite of age, did not appear to be crystalline. It is of interest to note that, from the records mentioned above, the percentage of failures of steel and iron connecting-rods and straps are about the same, and embrace all ages from eighteen months upwards. It cannot, therefore, be agreed that motion of this type has passed its useful or safe life; indeed, it is only when spare straps or rods in good condition are not available in stock from engines which have been scrapped, that these parts are replaced in steel to standard sizes with solid small ends. A process of annealing is now being tried in this connection.

As regards the question of reporting repairs, the company use a card system which was introduced some thirteen years ago. It has the advantage over the book system that a complete history of an engine is readily available at the station to which it belongs, and that once a repair is booked as necessary, the card should give all relevant information as to the work done, who did it, and the foreman responsible for passing it. There may be a certain amount of prejudice against the system on the ground that it is possible that cards may be lost, purposely or otherwise, and that therefore repairs which should have been done are not effected. But in the case under reference, cards were forthcoming, which showed that defects had been reported, and that either the repairs had not been carried out, or, if the engine had been examined and passed fit for service, the men responsible had failed to sign them. Of course, no system is infallible, and it is only on general results that it can be judged. It is sufficient to say that the company has found it to be more efficient than the book system, which, however, is that generally in use on other railways. Both methods require careful supervision, and, as the result of this inquiry, Major Mount has formed the opinion that the company's system may be capable of improvement in certain respects. The cards might with advantage be numbered, registered serially, and coloured differently for each shed or group of sheds. Kentish Town deals with fifty or sixty daily. The introduction of some counterfoil system in this connection would be of value, and would ensure complete and daily check on all defects reported. The cards or their counterfoils in the form of books should, if possible, be available at any time for scrutiny by drivers. He suggests that the company be asked to consider the practicability of improvement on these or similar lines, as this question is closely connected with that of inspection.

## THE BRITISH FINE CHEMICAL INDUSTRY.

An exhibition intended to illustrate by actual examples the application of the fine chemical industry to the needs of the State was held during the past week in the offices of the National Federation of Iron and Steel Manufacturers, at Caxton House, Tothill-street, Westminster. More than two thousand fine chemicals are now manufactured in Great Britain, and the most interesting and vital types were represented and their uses shown. The immediate bearing which the fine chemical industry has on both industrial and social life was demonstrated by diagrammatic charts and practical exhibits, which were arranged in the following groups:—Solvents and varnishes; photographic chemicals; analytical and research reagents; drugs; synthetic flavours and perfumes; rare earths; and general industrial fine chemicals. One of the most interesting exhibits was the display of special alloy steels made at the Brown-Firth laboratories and their associated works. The important part played by the use of fine chemicals in the extraction of the rare metals, such as tungsten, vanadium and molybdenum, from their ores, and in the control of the manufacturing processes of the new alloy steels was emphasised. High-speed steels and rustless steel, which is now finding such a general use, are products which are only obtained by a strict control of composition, and fine chemicals are essential to their manufacture. Brief reference may be made to the comparatively new industries engaged in the production of artificial silk and artificial leather, and to the various solvents and varnishes which are necessary for them, and for the manufacture of electrical insulating materials. Another branch of the chemical industry which has greatly increased in the years following the war is that concerned with photographic materials, for although in 1914 we were wholly dependent on Germany for a great many fine chemical materials, to-day they are produced by British makers in the requisite quantities and at prices favourable to the consumer. British drugs are now finding extensive use in the service of tropical medicine, surgery, and public health, and this branch of the fine chemical industry alone offers a vast field for British chemical research.

## BOOKS RECEIVED.

*Mathematical Handbook.* By W. H. F. Murdoch. London: Bowman and Murdoch, 99, Shoe-lane, E.C. 4. Price 2s. 6d. net.

*Some Things that Matter.* By Lord Riddell. London: Hodder and Stoughton, Limited, Warwick-square, E.C. 4. Price 7s. 6d. net.

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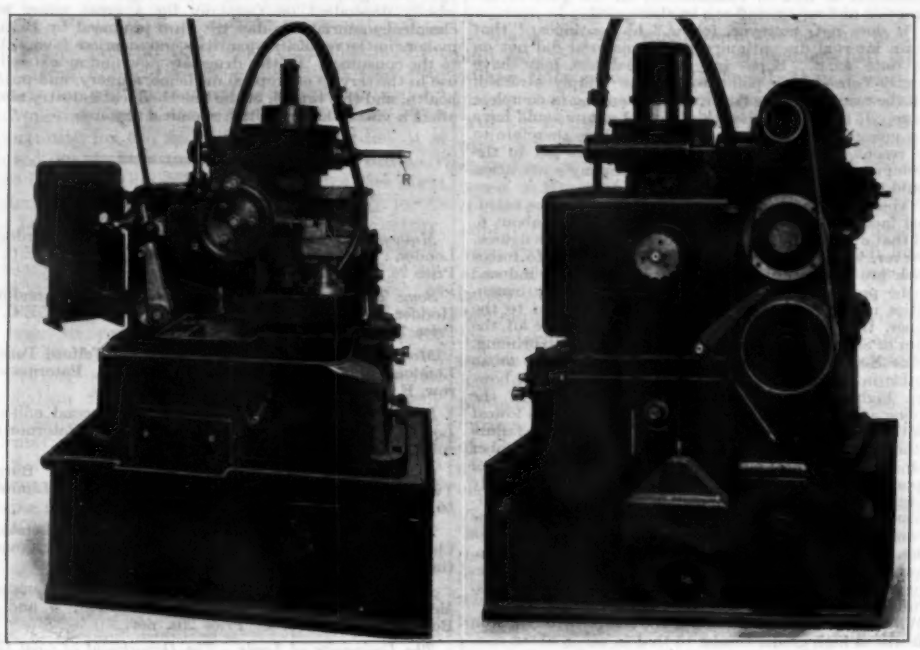
## A New High Speed Fellows Gear Shaper.

THE first example of a new type of Fellows gear shaping machine has recently been received from America, at the works of Alfred Herbert, Limited, for delivery to the Standard Motor Company. The new machine differs primarily from the type previously made by the Fellows Gear Shaper Company, in that it operates at a very high speed and normally cuts the gear blanks singly and not in gangs. It retains, however, the essential principle of the earlier design, namely, the generation of the gear teeth by means of a circular-toothed cutter, the teeth of which, after the cutter has been roughed out and hardened, are brought to the final form in a grinding machine which reproduces the generating action of the straight-sided rack-cutter used in the Sunderland and similar types of "direct" gear generators.



FIGS. 1 AND 2—NEW TYPE OF FELLOWS GEAR SHAPER

The practice of cutting gear wheel blanks in gangs is open to the objection that it is difficult to hold a number of superimposed blanks on an arbor or other fixture, without causing perceptible inaccuracies in the finished wheels. If, for instance, the blanks are machined inaccurately, say with their holes not accurately square with the faces, the cumulative effect upon the accuracy of the finished wheels may be considerable, the error in the example chosen consisting of an increasing degree of excentricity. Again, by adopting single blank cutting and a high speed, the Fellows Company claims that as the length of time during which the cutter is in contact with the work is greatly reduced, the heat generated is quickly dissipated. As a consequence the cutter remains cool and preserves its cutting edges in an improved manner, so much so, in fact, that the same cutter can be used for finishing as for roughing. In addition the work is also kept cool, so that there is a reduced likelihood of the wheel being cut inaccurately as a result of distortion caused by temperature changes. The economic practicability of cutting the blanks singly instead of in gangs is, of course, dependent upon the highness of the cutting speed. In the new No. 7 Fellows machine the cutting speed is such that the extra time lost in stopping and starting the machine between each gear blank is more than balanced by the time saved during the actual cutting operation.

The machine, it is to be noted, is intended to cut small wheels say up to about 7in. in diameter, such as are especially identified with automobile work. It is, therefore, practically never necessary to change its speed of cutting, that is to say, the cutter spindle reciprocates vertically at a constant number of strokes per minute. To accommodate the different degrees of hardness of different metals, seven feed changes are provided, that is to say, the number of strokes made by the cutter spindle per revolution of the cutter may have seven different values. These values range from 435 to 1735.

In addition to the reciprocation and rotation of the cutter the work has to be rotated at the rate at which the finished wheel would turn if meshed with a pinion having the same speed and the same number of teeth as the circular cutter. A fourth movement has to be provided, namely, a recession of the work away from the cutter on the up-stroke and its approach to the cutter on the down-stroke.

When set ready for starting the cutter teeth are just touching the periphery of the work. Immediately after starting the cutter is fed forward into the work, until it reaches almost the full depth of the tooth. Thereafter its forward feed ceases until the work has made about one complete turn and all the teeth have been roughed out. The cutter is then advanced a slight additional amount into the work and the work makes another turn—with a small amount of overlap—during which the finishing cut is taken. Altogether the work from start to finish makes about 2½ revolutions. Of this movement about 15 per cent. is occupied by the feeding in of the cutter, about 41.5 per cent. by the roughing cut, and about 43.5 per cent. by the finishing cut.

The cutter spindle is reciprocated vertically by means of the mechanism shown in Fig. 3. The arm A at one end carries a hardened steel toothed segment which meshes with a rack on the cutter slide. It is connected to the rod B through a ball bearing and a screw whereby the vertical position of the cutter stroke may be adjusted. The crank pin C is adjustable radially on the crank plate in order to permit the length of the cutter stroke to be varied. The lever A and the rod B are made of duralumin with the object of reducing the inertia stresses resulting from the high speed at which the machine is operated.

At the rear the crank shaft carries a fast and loose pulley, taking power by belt either from an overhead shaft or from a one horse-power motor, mounted on top of the machine frame.. The most economical method of driving, however, is stated to be to arrange a number of machines as one unit by bolting the bases together in a row and to take belts to each from an overhead shaft. So arranged, ten machines, we are informed, can be driven by a six horse-power motor.

Since the cutter reciprocates at a constant speed, variation of the feed—that is the number of strokes of the cutter per revolution of the cutter—will be effected simply by changing its speed. If, however, the cutter speed of rotation is changed the speed of rotation of the work must also be changed in proportion, in order that the "meshing" of the cutter with the work may be secured in accordance with the principle of generation adopted. These facts are expressed in the diagram, Fig. 6, showing certain portions of the internal mechanism of the machine. The crank plate shaft from which the reciprocation of the cutter is derived carries a worm D—see also Fig. 4—which transmits power through a worm wheel and two change wheels E F to a shaft G. From this shaft power is taken through two pairs of bevel wheels to a worm driving the upper index wheel H, that is the wheel rotating the cutter spindle. At the same time the shaft G drives through change gearing J K on to a shaft L—see also Fig. 5—from which shaft a second set of bevel gearing, embodying a reversing bevel for internal gear cutting, drives the lower index wheel M, that is the wheel rotating the work spindle. It will be seen then that any change of the gear wheels E F without a change of the wheels J K alters the rotary speed of the cutter and work in equal proportion, and therefore, since the reciprocating speed of the cutter is constant, increases or decreases the number of strokes made by the cutter in one of its revolutions. Any change in the gear wheels J K, on the other hand, alters the relative rotary speed of the cutter and blank, and, therefore, for a cutter with a given number of teeth the choice of the wheels J K determines the number of teeth cut on the blank.

The mechanism provided for giving the relief on the up stroke of the cutter is quite different from that used in the standard machine. The work spindle is mounted on an apron working on a machined seat on the bed. This apron is reciprocated through the agency of a lever and a connecting-rod by a cam at the rear of the machine.

The initial feeding-in of the cutter into the work at the beginning of the rough cutting period and the farther small feed applied just before the finishing cut is commenced, is effected by means of the cam N—Fig. 6. This cam is driven from the shaft L through gearing P and a worm and worm wheel, the latter being visible in Fig. 4, immediately above the wheel E. A diagram showing the approximate shape of the feed cam is given separately in Fig. 6. The cam works against a roller attached to the cutter saddle. When setting up the machine the cam is turned by means of the shaft Q—Fig. 3—until the highest part of the cam is just about to leave the roller, that is to say, until the cam and roller occupy the relative positions which they will have when the cutter has been fed into the work to the full depth of the tooth being cut. One tooth of the cutter is then brought into line with the axis of the work arbor, a movement effected by turning the upper indexing wheel through the agency of the shaft R—Fig. 1. The three nuts S—Fig. 7—are thereafter loosened, and by means of the handle T the cutter is advanced towards the work until a feeler will just pass between the work and the cutter tooth. The swinging worm U is then brought into engagement and a micrometer collar on its shaft is rotated until its zero is opposite a zero mark on the worm housing, the collar thereupon being fixed in this position on the shaft. None of these movements and adjustments affects the positions of the

FIG. 3—CUTTER RECIPROCATING MECHANISM

FIG. 4—CHANGE FEED GEARING

FIG. 5—CHANGE PITCH GEARING

cam and the roller. The latter is still in contact with the highest point of the former. At this stage, however, the cam is rotated again by means of the shaft Q until the roller drops into the depression in the cam and allows the cutter and saddle to move away from the work. The worm shaft U is then rotated so as to turn the cam and advances the cutter towards the work by an amount as shown by the micrometer collar, equal to the depth of the tooth to be cut plus the thickness of the feeler used in making the preliminary adjustment. With the worm shaft thrown out of gear and the dial nuts S tightened up the machine is ready for starting.

To this description of how the machine is set up it is only necessary to and by way of explanation as to the mechanism involved, that behind the cutter saddle there are two racks to the end of one of which the roller bearing against the cam is attached, while the other permits the saddle to be moved without disturbing the position of the cam roller. The two racks are locked together to act as one by means of the nuts S.

When the work is completely cut it may be necessary, easy to give—a three-cut cam might be required. When the change is required the feed cam is altered, and in addition the ratio of the gearing P is varied. For a two-cut cam the wheels P have 48 and 18 teeth. For a one or a three-cut cam they have 52 and 13 teeth. The two sets of gear wheels are provided in the machine as built and are operated by means of a sliding bush.

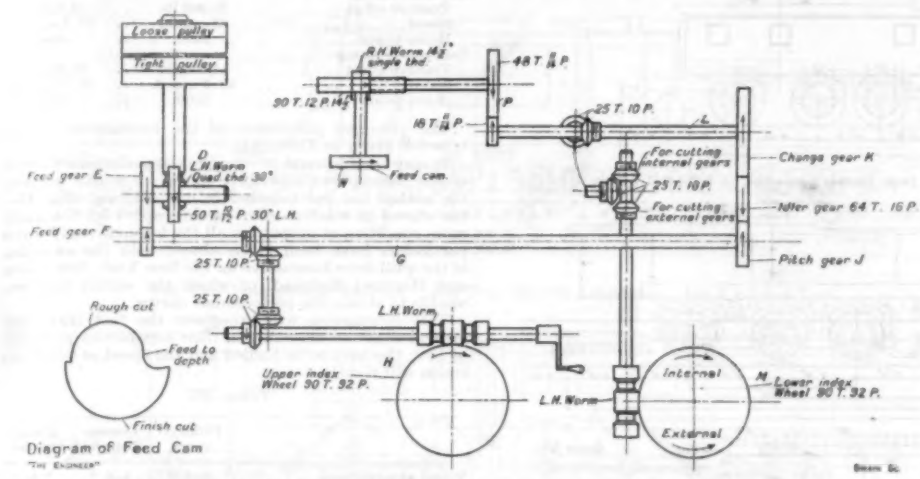



FIG. 6—DIAGRAMMATIC ARRANGEMENT OF INTERNAL MECHANISM OF GEAR SHAPER

in order to remove it or its fixtures from the machine, to move the cutter and saddle farther back than the depression in the cam will permit them to go. In such cases the stop pin V—Fig. 7—is withdrawn and the saddle moved back by means of the handle T. To reset the machine ready for cutting the next wheel of the batch it is only necessary to rotate the handle T in the reverse direction until the pin V drops back into position.

The following particulars of a test conducted on the machine by the makers will, we think, be studied with considerable interest.

*Material.*—S.A.E. standard transmission gear wheel, oil hardening, chrome-vanadium steel.
*Gear wheel.*—1in. face, 7/9 pitch,* 22 teeth.
*Speed of machine.*—700 strokes per minute.

Four tests were made using a different feed for each. Cutting oil was used for the first and second tests and cutting compound for the third and fourth. Throughout the tests the electric

FIG. 7—CUTTER ADJUSTING DETAILS

power factor was 0.70. The horse-power figures given represent peak or maximum load in all cases.

| Test No. | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Time to complete gear, two cuts | 5′40″ | 3′40″ | 2′30″ | 1′20″ |
| Amp'res consumed | 0.75 | 1.10 | 1.5 | 2.5 |
| Horse-power | 0.412 | 0.548 | 0.828 | 1.37 |

For the usual run of work the cam N—Fig. 6—is arranged as we have represented to complete the machining in two cuts. For some work, however, such as cast iron textile machinery gear wheels, a one-cut cam would be sufficient, while for other work—though examples are not

* "The stubbed tooth adopted by the Fellows Gear Shaper Company has an angle of obliquity of 20 deg. The tooth parts, however, do not bear a definite relation to the pitch, the addendum being made to correspond to a diametral pitch one or two sizes finer as :—

| Actual pitch | 2 | .... | 4 | 5 | 7 | .... | 14 |
|---|---|---|---|---|---|---|---|
| Pitch depth | 2½ | .... | 5 | 7 | 9 | .... | 18 |

The upper figures indicate the diametral pitch for tooth spacing and the lower figures indicate the diametral pitch from which the depth is taken."—Logue, "American Machinist Gear Book."

## Electric Locomotives.*

By Sir VINCENT L. RAVEN, K.B.E., Vice-president.

(*Concluded from page 674.*)

*Passenger Locomotives.*—While it may be possible to go some way in the direction of standardising the design of locomotives intended for goods work, it is hardly possible to arrive at any definite conclusion in regard to the best design of locomotive for all sorts of passenger traffic. There are several reasons for this. In the first place, the weights of trains vary considerably, as also the speed and the nature of the line, the gradients, &c. For example, on the Chicago, Milwaukee and St. Paul Railroad, the daily trains generally consist of twelve coaches, weighing on the average 70 to 75 tons each, and these have to be hauled up gradients as steep as 1 in 45. Partly on account of these gradients and partly because of the curvature of the line, the speed of these trains seldom rises much above 45 miles per hour, although, where circumstances permit, higher speeds can be and are reached. On the British railways much lighter coaches are in use, and the average number of coaches in a train is probably not more than eight or nine. Speeds also vary, some expresses maintaining a speed of over 60 miles per hour for considerable distances, while local trains average about 30 miles per hour with frequent stops.

Secondly, many discussions have taken place as to the behaviour of locomotives of different designs when running at high speeds, such as those frequently attained on British railways. A locomotive of unsuitable design may start oscillating or "nosing," and the oscillations may reach such a degree as to injure the track or the locomotive. A number of special designs have been evolved with a view to the avoidance of these oscillations, but it cannot be said that there is yet any complete understanding as to the origin of the trouble, or agreement as to the best way of guarding against it. This point is discussed in more detail below.

Dealing first with the requirements for a standard passenger locomotive for the British railways, there are the following points to take into account :—

(1) Is it necessary that there should be more than one class of locomotive for all kinds of passenger traffic ?

(2) If one class is sufficient, for what tractive effort and speed should the locomotive be designed, and can it be economically used for goods traffic when necessary ?

* The Institution of Mechanical Engineers, Paris Meeting, June, 1922.

In regard to the first question, it may seem at first sight obviously wrong to have only one class of locomotive for heavy fast expresses and for light local trains. A locomotive for heavy express work is necessarily somewhat expensive, and it is clearly not economical to use it regularly for light duty. On the other hand, there is a good deal of advantage in keeping down as much as possible the number of classes of locomotive.

The answer to this question, at all events, for the conditions on British railways, is to use the same engine for all expresses and fast trains running considerable distances without stopping, including all passenger trains which run beyond the limits of any electrified section, and to equip a sufficient number of trains as multiple unit trains without locomotives for the local passenger service. If this is done, the advantages of electrification can be obtained for both classes of passenger traffic economically and conveniently.

As a reply to the second question, some particulars may be given of the capacity of the passenger locomotive which has just been completed by the North-Eastern Railway for experimental purposes. Full particulars of this engine are given below, and the general design may be seen from the outline drawing in Fig. 12. The conditions specified for the electrical equipment are as follows :—

(1) The adhesion weight of the locomotive will be not less than 17 tons per driving axle, and the complete electrical equipment shall be such that the motors can exert sufficient torque to skid the wheels without injury to themselves or to any part of the equipment.

(2) The motors shall be able to exert a total average tractive effort of 16,000 lb. at the tread of the driving wheels when starting under normal conditions on level track.

(3) The capacity of the complete equipment shall be sufficient to enable the locomotive when coupled to a train weighing 450 tons to start from rest on a rising gradient of 1 in 78, and accelerate up to the first economical running speed without injury to any part of the equipment.

(4) The speed of the motors and gearing shall not exceed the limits of safety when the locomotive is travelling at 90 miles per hour.

(5) The locomotive shall be capable of hauling a train of fourteen main line coaches weighing, with load, 450 tons, at not less than 65 miles per hour on straight level track.

As will be seen from the schedule of particulars below, the electrical equipment consists of three pairs of motors, each motor having a capacity of 300 horse-power, so that

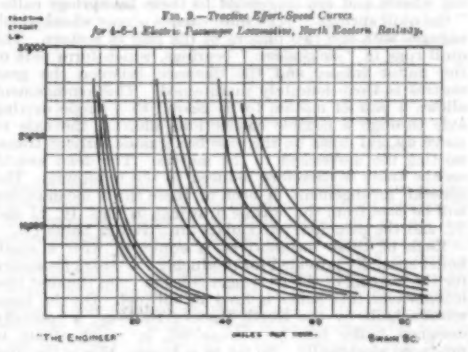



FIG. 9.—Tractive Effort-Speed Curves for 4-6-4 Electric Passenger Locomotive, North Eastern Railway.

the total capacity of the locomotive—one hour rating—is 1800 horse-power, measured at the tread of the wheels.

The use of three pairs of motors enables a wide range of speed to be obtained, as in the goods locomotive for the Paulista Railway previously mentioned, by grouping the six motors—(1) all in series ; (2) three in series, two in parallel ; (3) two in series, three in parallel. With each grouping provision is made in the control equipment for regulating the speed by reducing the excitation of the motor fields. Thus there are for each grouping four different degrees of excitation, namely, full field, 18 per cent. reduction, 31 per cent. reduction and 40 per cent. reduction. With this arrangement, twelve different speeds are available for any particular value of the tractive effort. The performance curves, showing the relation between speed and tractive effort, as determined by workshop tests, are given in Fig. 9.

From these curves it will be seen that the maximum tractive effort corresponding to a speed of 65 miles per hour is 8400 lb., or 3¾ tons. The tractive resistance of the locomotive alone at this speed, including that due to windage, should not be more than about 1600 lb. The draw-bar pull would therefore be about 6800 lb., equivalent to about 15 lb. per ton for a 450-ton train. This should be ample to maintain a speed of 65 miles per hour on the level under any ordinary conditions of weather.

Referring again to the performance curves in Fig. 9, it will be seen that a tractive effort of 8000 lb. to 10,000 lb. can be obtained at a speed of 31 to 34 miles per hour. Allowing, say, 900 lb. for the tractive resistance of the locomotive alone, the draw-bar pull available at a speed suitable for goods train working is about 7000 lb. to 9000 lb. This should be quite sufficient for a train of 600 tons. The speed of such a train up a 1 in 100 gradient would be about 24 miles per hour, which corresponds closely to the conditions of operation already advocated above in connection with the design of a standard goods locomotive. A goods train of 600 tons is a reasonable load for a return trip of a passenger engine on a section in which the ruling gradient is about 1 in 100. It would be hardly worth while, from a traffic point of view, to occupy the line with a smaller train than this—at all events, if the line is working anywhere near its full capacity—and it would be better to let the passenger locomotive lie-over until required to work a return trip with a passenger train.

The following brief reference may be made to locomotives that have been designed and built for express passenger traffic. Those which are not intended for high-speed running are not included, as no special problem is raised in the design of engines for hauling passenger

trains up steep gradients at comparatively low speed. Three distinct types may be mentioned differing in the method of drive, namely:—(*a*) Geared locomotives with twin motors and quills; (*b*) gearless locomotives with the motor armatures built on the driving axles; (*c*) gearless locomotives with transmission by connecting-rods.

(*a*) Of the first type there are three examples, namely, the passenger locomotives of the New York, New Haven and Hartford Railroad, the Chicago, Milwaukee and St. Paul Railroad, and the North-Eastern Railway respectively. In each case the motors are grouped in sets of three pairs, in the first two there being two such groups, and in the third only one. Each pair of motors is mounted in the locomotive framework immediately above the corresponding driving axle. Concentric with this axle is a hollow shaft or quill, carrying at each end a spider. The arms of this spider mesh with the spokes of the driving wheels and are connected to them by springs called "the quill springs." The quill carries a gear wheel which engages with the two pinions of the pair of motors. The quill runs in "suspension" bearings, which form part of the motor frame, and the distance between the gear centres is thus definitely maintained. This arrangement allows a pair of motors to be geared to a single driving axle through a flexible connection, allowing the axle to move up and down on the axle box guides without transmitting the movement to the motors. The dead weight on the track is therefore reduced to the minimum. The general arrangement of each of these three locomotives will be seen from the outline drawings in Figs. 10, 11 and 12, and the principal particulars are given in Table IX.

Each of these locomotives is equipped with a small boiler specially provided for producing the steam necessary for the heating of the passenger coaches. On the first two locomotives this boiler is fired by oil fuel. On the locomotive built by the North-Eastern Railway, a specially designed boiler has been installed, in which steam is produced electrically. So far as is known, this is the first electric boiler used for this purpose in which the heating elements are designed for direct current at a pressure of 1500 volts. Electric boilers have been in service for some years on lines electrified on the alternating-current system, where, of course, it is a simple matter to provide a small step-down transformer so that the necessary electrical energy may be supplied to the boiler at a suitable low pressure. To do the same thing on a 1500-volt direct-current circuit would require the provision in the locomotive of a motor generator of about 300 kilowatts capacity. Such a motor generator would, of course, be an unwelcome addition to the electrical equipment of the locomotive. For this reason, there is a definite advantage in the use of a boiler which is suitable for the line pressure of 1500 volts.

The boiler is of the fire-tube type, each tube containing a heating element consisting of a tube of quartz in the interior of which there is a spiral of high resistance wire. The boiler contains in all 144 of these elements, and switchgear is provided so that the number of elements in circuit can be reduced as desired when the full output is not required from the boiler. The maximum output is about 1000 lb. of steam per hour at a pressure of 120 lb. per square inch.

(*b*) Of the second type there are two well-known examples

TABLE IX.

| | N.Y., N.H. and H. | C., M. and St. P. | N.E.R. |
|---|---|---|---|
| Wheel arrangement | 2–6–2 + 2–6–2 | 4–6–2 + 2–6–4 | 4–6–4 |
| Electrical system | D.C. and single ph. | D.C. | D.C. |
| Voltage | 600 and 11,000 | 3000 | 1500 |
| Length overall | 69ft. | 88ft. 7in. | 53ft. 6in. |
| Width overall | 10ft. 2in. | 11ft. 0¼in. | 8ft. 10in. |
| Height, pantograph locked down | 14ft. 2in. | 17ft. | 13ft. 0¼in. |
| Driving wheel diameter | 63in. | 68in. | 80in. |
| Pony wheel diameter | 36in. | 36in. | 43⅜in. |
| Rigid wheel base | 14ft. 3in. | 16ft. 9in. | 16ft. |
| Weight of locomotive | 161 tons | 245 tons | 102 tons |
| Weight per driving axle | 18 tons | 25 tons | 18½ tons |
| One hour rating— | | | |
| Tractive effort | 21,000 lb. | 66,000 lb. | 15,900 lb. |
| Speed, m.p.h. | 45.6 | 23.8 | 43 |
| Horse-power | 2550 | 4200 | 1800 |
| Continuous rating— | | | |
| Tractive effort | 14,500 lb. | 40,800 lb. | 9,480 lb. |
| Speed, m.p.h. | 52.5 | 30.4 | 51.5 |
| Horse-power | 2025 | 3400 | 1300 |

—namely, the passenger locomotives on the New York Central Railroad, and the Chicago, Milwaukee and St. Paul Railroad.

The special feature of both these locomotives is the design and arrangement of the motors. Each armature is built direct on its driving axle, thus eliminating altogether all gearing, armature bearings, armature shafts, &c., incidental to other designs. The rest of the motor—that is, the magnetic circuit with the field coils—is built into the structure of the bogie or truck frame, and the poles, of which there are only two, arranged on the horizontal axis, are specially shaped to allow the armature to move up and down with the driving axle without fouling the pole tips.

The general arrangement of each of these locomotives is shown in Figs. 13 and 14. The New York Central locomotive, which has replaced an earlier type of gearless locomotive now used for shunting operations, has eight

FIG. 10.—*New York, New Haven and Hartford Railroad. Quill Drive Electric Locomotive.* 2-6-2 + 2-6-2 Type

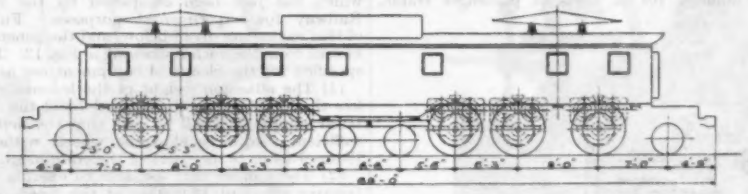
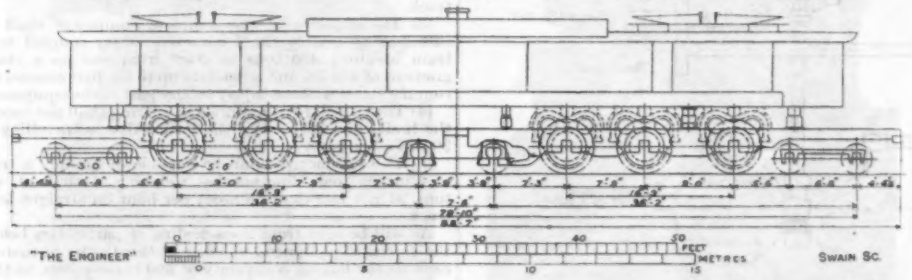


FIG. 11.—*Chicago, Milwaukee and St. Paul Railroad. Quill Drive Electric Locomotive.* 4-6-2 + 2-6-4 Type.




axles, all driven. The body is carried by pivots on two trucks, articulated at their inner ends. Each truck has two fixed driving axles and a four-wheeled bogie. The Chicago, Milwaukee and St. Paul Railroad locomotive consists also of two trucks, but in this case each truck has four axles and a three-axle bogie, the latter containing two driving axles and one guiding axle. Each of the two trucks carries a superstructure containing the electrical control apparatus, and between these two superstructures is suspended a central body containing the boiler required for heating the passenger coaches by steam.

The principal particulars of these two locomotives are given in Table X.

(*c*) Of the third type, namely, that in which the torque is transmitted to the driving axles by means of cranks and coupling-rods, only three will be mentioned, namely, the Pennsylvania Railroad locomotives, built in 1910, the passenger locomotive built for the Dessau-Bitterfeld section of the Prussian State Railways in 1912, and the locomotives recently built by the Paris–Orleans Railway for the line Paris–Quai d'Orsay to Juvisy. A good many other locomotives have been built in the last ten or twelve years of this general type, which are used for hauling passenger trains, such as those on the Italian State Railways, the Lötschberg Railway, the Swiss Federal Railways, and elsewhere, but in no case is the average speed over considerable distances above or equal to 60 miles per hour.

The general arrangement of each of the three locomotives mentioned above is shown in the outline drawings, Figs. 15, 16 and 17. The Pennsylvania locomotive consists of two 4–4–0 engines short-coupled back to back, each engine containing a single motor driving by means of inclined coupling-rods a jack shaft and horizontal rods.

The Dessau-Bitterfeld locomotive has a wheel arrangement 4–4–2, and contains a single motor driving by means of vertical rods a jack shaft and horizontal rods.

The Paris–Orleans locomotive has a wheel arrangement 2–8–2, and contains two motors which drive through inclined and horizontal coupling-rods.

TABLE X.

| | New York Central Railroad. | C., M. & St. P. Railroad. |
|---|---|---|
| Wheel arrangement | 4–4–4–4 | 2–4–8–8–4–2 |
| Electrical system | Direct current | Direct current |
| Voltage | 600 | 3000 |
| Length overall | 57ft. | 76ft. |
| Width overall | 10ft. 1¼in. | 10ft. |
| Height, pantograph locked down | 14ft. 6in. | 16ft. 8in. |
| Driving wheel diameter | 36in. | 44in. |
| Pony wheel diameter | None | 36in. |
| Rigid wheel base | 6ft. 6in. | 13ft. 9in. |
| Total wheel base | 46ft. 5in. | 67ft. |
| Weight of locomotive | 118 tons | 236 tons |
| Weight per driving axle | 14.75 tons | 17 tons |
| One hour rating— | | |
| Tractive effort | 20,000 lb. | 46,000 lb. |
| Speed | 49 m.p.h. | 27.5 m.p.h. |
| Horse-power | 2800 | 3480 |
| Continuous rating— | | |
| Tractive effort | 14,000 lb. | 32,000 lb. |
| Speed | 58.3 m.p.h. | 37.8 m.p.h. |
| Horse-power | 2000 | 3200 |

The principal particulars of the locomotives of this type are given in Table XI.

It may be of interest to compare the performance curves of the locomotives described above. For this purpose, the author has put together in one diagram—Fig. 18—the curves of tractive effort against speed for the maximum condition of output for all the locomotives of which particulars have been given above, with the exception of the quill drive locomotive for the New York, New Haven and Hartford Railroad, of which the author has been unable to obtain the performance curves.

This comparison will bring out the fact that these engines differ considerably in their capabilities in respect of both the load to be hauled and the speed at which the trains will travel.

TABLE XI.

| | Pennsylvania. | Dessau-Bitterfeld | Paris–Orleans. |
|---|---|---|---|
| Wheel arrangement | 4–4–0 + 0–4–4 | 4–4–2 | 2–8–2 |
| Electrical system | Direct current | Single ph. 15 cycles | Direct current |
| Voltage | 600 | 10,000 | 600 |
| Length overall | 64ft. 11in. | 41ft. | 40ft. |
| Width overall | 10ft. 6in. | 9ft. 11in. | 10ft. 2in. |
| Driving wheel diameter | 72in. | 63in. | 59in. |
| Pony wheel diameter | 36in. | 39⅜in. | 33$^{19}/_{64}$in. |
| Rigid wheel base | 7ft. 2in. | — | 8ft. 9in. |
| Weight of locomotive, tons | 140 | 72.25 | 85.6 |
| Weight per driving axle, tons | 21.75 | 15.125 | 16.8 |
| One hour rating— | | | |
| Tractive effort | 20,150 | 12,000 | — |
| Speed | 32.6 | 31.3 | — |
| Horse-power | 1750 | 1000 | 2000 |

For example, the quill-drive locomotive employed for passenger work on the Chicago, Milwaukee and St. Paul Railroad has a tractive effort of only 7200 lb. at a speed of 65 miles per hour, as compared with 8400 lb. at the same speed for the North-Eastern Railway locomotive, in spite of the fact that the latter has only six 300 horse-power motors, whereas the former has twelve motors, each of 350 horse-power. On the other hand, the Chicago, Milwaukee and St. Paul locomotive, having approximately three times as much weight on the driving wheels as the North-Eastern Railway locomotive, is able to exert a far greater tractive effort at low speeds, and, in fact, is intended principally for hauling trains of about 800 tons up gradients as steep as 1 in 45.

A comparison of these various curves shows that the North-Eastern Railway locomotive is well adapted to deal with the loads for which it is intended, and at the speeds at which it is desired to run, without being heavier or more powerful than is necessary for this duty.

FIG. 12.—*North Eastern Railway. High-Speed Electric Passenger Locomotive.* 4-6-4 Type.

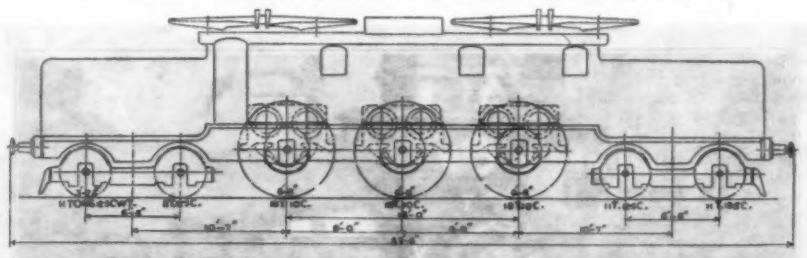
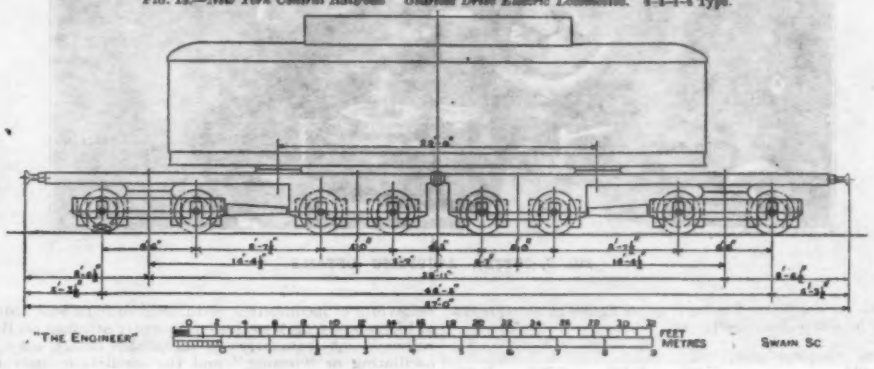


FIG. 13.—*New York Central Railroad. Gearless Drive Electric Locomotive.* 4-4-4-4 Type.



While it is clear, therefore, that all these locomotives are not equally well suited to meet the requirements of express passenger traffic on the British railways, it does not follow that a suitable locomotive cannot be designed embodying any one of the systems of drive peculiar to the three general types mentioned above. Whatever the merits or demerits of type (*a*), the particulars already given of the locomotive just completed by the North-Eastern Railway show that the tractive effort and speed characteristics desired can be obtained without difficulty. Equally with type (*b*), the same characteristics can be obtained by proper design of the motors and the diameter of the driving wheels. The arrangement of drive lends itself well to high-speed running. The higher the speed the greater the peripheral velocity of the motor armature mounted direct on the driving axle, and consequently better use is made of the active material of the motor. As an illustration of this point, it may be mentioned that

FIG. 14.—*Chicago, Milwaukee and St. Paul Railroad. Gearless Electric Locomotive.* 2-4-8 + 8-4-2 Type.

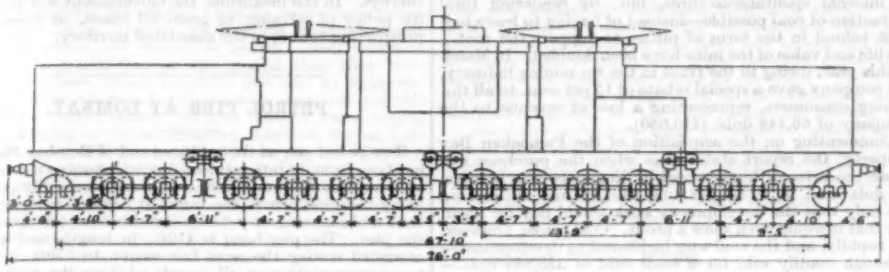
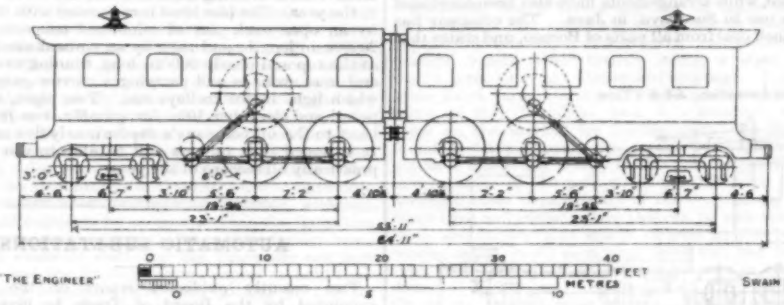


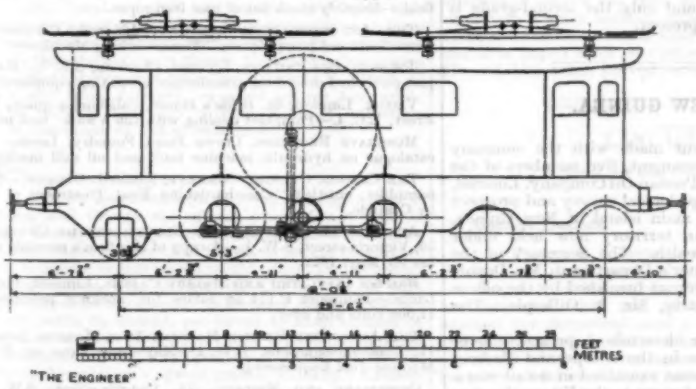
FIG. 15.—*Pennsylvania Railroad. Rod Drive Electric Locomotive.* 4-4-0 + 0-4-4 Type.




about the time when the order for the electrical equipment for the North-Eastern Railway passenger locomotive was placed with the Metropolitan-Vickers Company, a proposal was submitted by the General Electric Company, U.S.A., for a locomotive with direct drive gearless motors to conform to the same specification. For various reasons, it was decided to postpone the building of this second engine, but the following particulars of the design may be of interest, the general arrangement being shown in the outline drawing—Fig. 19.

So far as type (*c*) is concerned, namely, the design in which coupled wheels are driven by cranks and rods, it is obviously a simple matter to provide for any desired tractive effort-speed characteristic by a proper selection of the diameter of the driving wheels and a suitable design of the driving motor or motors. There need be no gearing, and there is therefore no limitation in respect of gear velocity to be taken into account. If a high speed is

FIG. 16.—*Prussian State Railways. Passenger Electric Locomotive.* 2-4-4 Type.




desired, it is a simple matter to increase the wheel diameter, keeping the crank radius the same.

It is clear, therefore, that so far as the system of drive is concerned, any one of the three general schemes referred to above can be selected. Apart from this, however, there are two questions to consider, namely—(1) Is there any outstanding advantage in any one of the three types over the others? (2) What should be the general mechanical arrangement of an express passenger locomotive to suit the requirements of British railways?

In view of the small experience which has so far been acquired of working express passenger traffic by electric locomotives, it is hardly possible yet to come to any conclusion as to whether one or other of the three types mentioned above is definitely to be preferred to the others. One can safely say that as regards the first two types, namely, the quill drive and the gearless motor, each has its own good points.

The advantages of the quill drive may be stated as follows:—The dead weight on the track is reduced to the minimum as the motor is entirely spring-borne, the motors are geared, and therefore can be designed for a satisfactory peripheral speed, thus enabling the fullest use to be made of the active material, and, finally, the centre of gravity of the complete locomotive is reasonably high, owing to the use of driving wheels of large diameter and the mounting of the motors above the centres of the driving axles.

For example, on the 4-6-4 locomotive, built by the North-Eastern Railway, the dead weight per axle consists only of the two driving wheels and the axle, which weigh 4 tons 15 cwt., and as the diameter of the driving wheels is 6ft. 8in., the effect of this dead weight on the track will be much less than in another case, where the weight might be the same and the diameter of the driving wheels, say, 4ft. On the same locomotive the peripheral velocity of the armatures corresponding to a locomotive speed of 75 miles per hour is 5560ft. per minute, and the centre of gravity of the complete locomotive is about 4ft. 10in. above rail level.

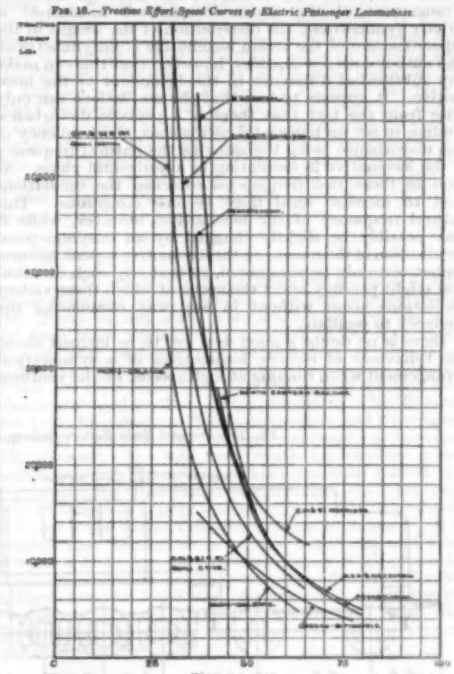
On the other hand, the advantages of the gearless locomotive are as follows:—The electrical equipment is extremely simple, there being no gearing, no special armature shafts, armature bearings, suspension bearings, &c. There is also no necessity for the expensive quill with the spiders and quill springs. These points tend to compensate for the higher cost of the motor itself, which, by reason of its low peripheral speed, is comparatively expensive. It is also claimed that the simplicity of the electrical arrangements leads to a lower cost of maintenance than is possible with any form of geared motor, combined with quill drive.

For example, in the gearless locomotive, which the General Electric Company proposed to supply to the North-Eastern Railway, the dead weight per axle with driving wheels of only 42in. would be 3 tons, and the peripheral velocity of the armature at a locomotive speed of 75 miles per hour would be only 3540ft. per minute.

In regard to the third type, namely, that in which the power is transmitted to the driving wheels by means of cranks and coupling-rods, the view has already been expressed in reference to the freight locomotives that there are inherent disadvantages in the use of coupling-rods from which other forms of transmission are free. For express passenger locomotives it may be claimed that owing to the higher speed it is easier to run the armatures at the desired high peripheral velocity without the use of gearing. This, however, can only be done by the use of comparatively small driving wheels which with their cranks must revolve at a speed considerably above that in common practice with steam locomotives.

As the revolving masses of the cranks, coupling-rods, &c., cannot be exactly counter-balanced, this high speed is liable to give rise to considerable vertical oscillations.

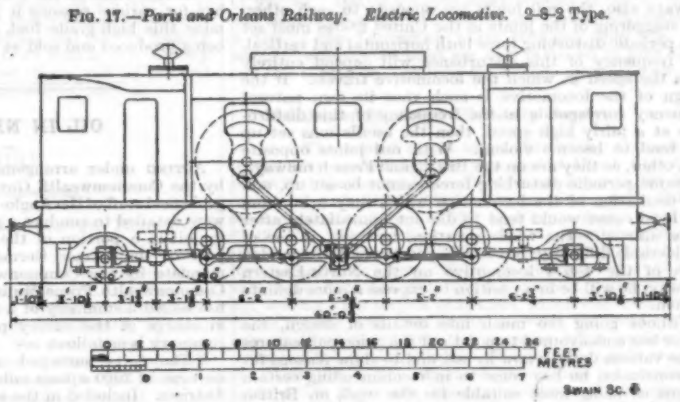
FIG. 18.—*Tractive Effort-Speed Curves of Electric Passenger Locomotives.*




It may be that by careful design a suitable locomotive could be constructed on this principle which would run at the speeds required for express passenger traffic on British railways, but even if this were successful there is still the drawback that the maintenance cost of the various crank pin bearings, jack shaft bearings, &c., would be unduly high. In the author's opinion, therefore, the choice at present lies between the first two types, namely, the quill drive and the gearless locomotive, and further experience is necessary before any decisive opinion can be expressed as to which of these two types is to be preferred.

The question as to the most satisfactory mechanical arrangement of an express passenger locomotive for the British railways must be considered in reference to the discussion, which has been occupying the attention of railway engineers for some time now, in regard to the possibility of oscillations or nosing of the locomotive when running at high speeds. Experience in the United States with various designs of locomotives, we are assured, has proved that an electric locomotive cannot be expected to travel satisfactorily at such speeds as we are considering, say, 70 to 75 miles per hour, if the wheel arrangement is symmetrical. For example, a 4-6-2 locomotive might perhaps be satisfactory, whereas a 4-6-4 locomotive would be unsatisfactory. This, of course, is an important point if one bears in mind that one of the advantages of electric working is that there is no necessity for turning the locomotive at the end of each journey. This is only possible if the locomotive can run equally well in both directions. For such speeds as we are considering, it might be quite satisfactory to run a 4-6-2 locomotive with the bogie leading, but not with the bogie trailing, and therefore it is desirable that in whichever direction the locomotive runs, there should be a bogie leading.

FIG. 17.—*Paris and Orleans Railway. Electric Locomotive.* 2-8-2 Type.




Engineers in the United States who have considered this matter, advocate a construction which, while not symmetrical, does provide for a bogie at each end of the locomotive. For this purpose they recommend one or other of the various designs which are based on the articulation of two locomotives back to back. Thus, for example, they have suggested at one time and another locomotives having wheel arrangements 4-6-0 + 0-6-4, with the idea that while the locomotive, considered as a whole, is symmetrical, each part of the locomotive is unsymmetrical, and that therefore each part will run satisfactorily without setting up violent oscillations of the locomotive as a whole.

It is difficult to find any satisfactory explanation of the difficulties which have been experienced in the United States in this direction, especially in view of the fact that there are on the British and continental railways already a fair number of symmetrical locomotives which are capable of running at high speeds. Before coming to any decision to build the 4-6-4 electric locomotive for the

North-Eastern Railway, the author inquired as to the behaviour of the steam locomotives possessed by the Chemins de Fer du Nord of the 4–6–4-type, and Mr. Briville, the chief engineer of the company, kindly wrote saying that experience showed that their locomotives of this design were capable of attaining a maximum speed of 120 kiloms. per hour (75 miles per hour) without experiencing any difficulty in regard to oscillations.

On the London, Brighton and South Coast Railway they have for some years run engines of the symmetrical type—4–6–4—and Mr. Billinton states that he has made oscillation tests which have shown satisfactory results.

The North-Eastern Railway have a 4–4–4 symmetrical type which has run up to 70 miles per hour without finding any ill effects.

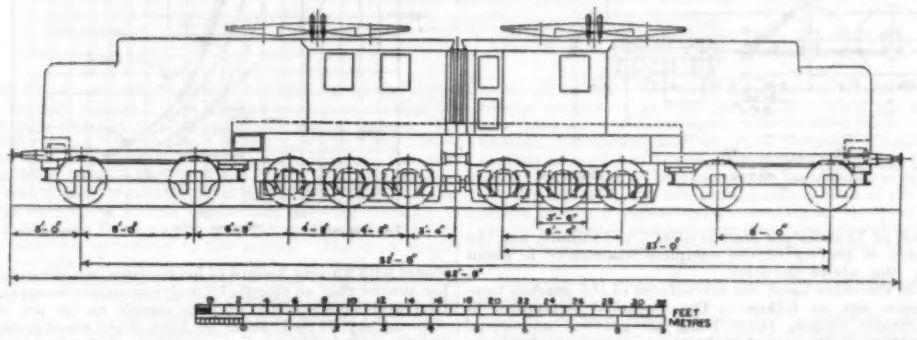
In view of this, it is evident that there must be some cause which gives rise to violent oscillations on symmetrical electric locomotives when running in the United States which are absent when symmetrical steam locomotives are run in Europe. It may be argued that although the wheel arrangement of the steam locomotives mentioned is strictly symmetrical, the distribution of the weight in the superstructure of the steam locomotive is unsymmetrical. The author does not consider, however, that this can make any substantial difference in the behaviour of the locomotive. It appears to him that the oscillations can only arise from the fact that there is a periodic disturbance tending to set up horizontal oscillations, the frequency of this disturbance being the same as the natural frequency of the locomotive in oscillating in a horizontal plane. As soon as these two frequencies coincide, the oscillations tend to increase until they become dangerous. This natural frequency of the locomotive, however, while it may possibly be slightly changed by an unsymmetrical distribution of the masses on the locomotive superstructure, cannot certainly be eliminated, so that any such distribution might possibly affect the speed at which these violent oscillations occur without in any way eliminating the tendency to oscillate.

There is no doubt a good deal yet to be learned about the behaviour of electric locomotives of a symmetrical arrangement when running at high speeds, but he ventures to suggest that one possible cause of the trouble experienced n the United States and from which the European railways seem to be free, is that on practically all the railways in the United States the rail joints are staggered, whereas on the British railways, and, he understands, on the French railways also, the rail joints are opposite to each other. The staggering of the joints in the United States must set up a periodic disturbing force both horizontal and vertical. The frequency of this disturbance will depend entirely upon the speed at which the locomotive travels. If the design of the locomotive is such that its own natural frequency corresponds to the frequency of this disturbance at a fairly high speed, then the oscillations set up will tend to become violent. With rail joints opposite each other, as they are on the British and French railways, the same periodic disturbing force cannot be set up, and any oscillation of the locomotive which may arise from any local cause would tend to die out immediately after it has started. The whole question, however, is one of considerable difficulty, but it is hoped that after extended trials of the 4–6–4 locomotive on the North-Eastern Railway, he will be in a position to express a more definite opinion.

Without going too much into details of design, the author has endeavoured to point out the principal features of the various designs now in use, and to show reasons for the conclusion he has come to in recommending certain designs as being most suitable for the work on British railways. It is important, however, the types should be as few as possible from an economic point of view, and he considers that it is possible to confine these to within five separate designs.

In conclusion, the author wishes to take this opportunity of thanking Mr. F. Lydall for the very valuable assistance he has given him in connection with this paper.

Fig. 19.—*Proposed North Eastern Railway. Gearless Electric Locomotive.* 4-6-6-4 Type.




| | | | |
|---|---|---|---|
| Wheel arrangement | 4-6-6-4. | Total wheel base | 52 ft. 6 in. |
| Electrical system | Direct current | Weight of Locomotive (approximately) | 105 tons. |
| Voltage | 1,500. | Weight on driving wheels (approximately) | 67 tons. |
| Length overall | 69 ft. 8 in. | Number of motors | 6. |
| Driving-wheel diameter | 43 in. | Horse-power per motor (one hour rating) | 900. |
| Bogie wheel diameter | 43 in. | Tractive effort (one hour rating) | 14,000 lb. |
| Rigid wheel base | 8 ft. 4 in. | Speed (one hour rating) | 47 m.p.h. |

"THE ENGINEER" SWAIN SC.

EARLY in July the registration of seats on payment of 1s. per seat, on the Great Western Railway, will be extended and improved. Seats can then be reserved by post also. Plans of the trains will be kept at the stations which will show the first and third and smoking and non-smoking compartments and the numbers of the seats. The arrangement will be a decided public convenience; at the same time it will benefit the company financially—like the platform tickets—and will enable it to gauge the probable traffic.

## COAL MINING IN THE FEDERATED MALAY STATES.

COVERING a period of eighteen months to December 31st last, the eighth annual report of the Malayan Collieries, Limited, contains some interesting information. The company has acquired the Mynbouw en Handel Maatschappii Goenoeng Batoe Besar, a Dutch concern holding mining and timber leases in Dutch South-East Borneo (Pamoekan Bay Colliery), and during the period covered by the report, the total output of both its mines amounted to 489,243 tons. Of this total, Batu Arang, in Selangor, contributed 472,859 tons, and Pamoekan Bay 16,384 tons. At Batu Arang 24,451 tons were consumed for generating power, and at Pamoekan Bay 1823 tons for power and in bunkering the company's vessels. Coal sales amounted to 462,969 tons—448,408 tons at Batu Arang and 14,561 tons at Pamoekan Bay. By the introduction of hydraulic sand stowage, not only is the mine at Batu Arang being rendered safe from its former greatest danger of internal spontaneous fires, but, by rendering total extraction of coal possible—instead of having to leave half of it behind in the form of pillars to support the roof—the life and value of the mine have been doubled. In March of this year, owing to the crisis in the tin-mining industry, the company gave a special rebate of 15 per cent. to all tin-mining consumers, representing a loss of revenue to the company of 86,148 dols. (£10,050).

Commenting on the acquisition of the Pamoekan Bay property, the report states that when the purchase was made the price of bunker coal in Singapore was between 40 dols. and 50 dols. per ton, and it was anticipated not only that the development work would pay for itself, but that it would even show a profit. Coal prices, however, fell rapidly, and the coal won incidental to development—although readily sold for a total sum of 335,888 dols.—did not go very far towards reducing the total development expenditure. A coal storage ground has been leased in Singapore, while arrangements have also been concluded to acquire one in Surabaya, in Java. The company has now examined coal from all parts of Borneo, and states that it has found no Borneo coal equal in quality even to the company's second-grade Pamoekan Bay coal, whilst most Borneo coals are decidedly inferior to it. The company's first-grade Pamoekan Bay coal is reported as being equal in calorific value to the best Australian bituminous coals; but for various reasons it is not considered advisable to mine this high-grade fuel, and only the second-grade is being produced and sold at present.

## OIL IN NEW GUINEA.

ACTING under arrangement made with the company by the Commonwealth Government, five members of the geological staff of the Anglo-Persian Oil Company, Limited, were detailed to conduct a geological survey and prospect for oil in a portion of the main island of New Guinea, part of the former German territory now held under mandate by the Commonwealth. The Secretary of the Commonwealth Prime Minister's Department, Mr. Deane, has issued a summary of a report furnished by the officer in charge of the survey party, Mr. A. Gillespie. The summary is as follows:—

"The party surveyed or determined prospects over an area of 2000 square miles in the Eitape and Madang districts. Included in the areas examined in detail was a stretch of about fifty miles of coast in the Eitape district, which included the outfall of the Wakip River, on which oil seepages were known to exist. This river flows into the sea on the north coast of New Guinea, about 150 miles easterly from the Dutch frontier, and oil seepages in its vicinity were known to the German Government, and were examined during the military occupation by the Australian forces, although no detailed study of the geological structure was made.

"A small scale map of this area was made by the Anglo-Persian Company's geologists, and its geological structure and tectonics were studied in detail. The seepages of oil already reported were found. There are two main groups, each being situated on a well-marked fault plane. As a result of their examination of the general geology of the district, the geologists reported that, while small quantities of oil could probably be obtained in the immediate vicinity of the main seepages, they believed that such operations would probably not repay outlay and working costs, and they could not recommend a test well.

"The geologists, reporting generally on the areas they examined, said that the oil prospects were unfavourable. The prevalence of intrusive dykes ramifying the sedimentary series, the extensive system of strike faulting, the absence or insufficient development of anticlinal structures, the steep inclination of strata, and the unpetroliferous nature of the great thickness of rocks above the horizon of the oil-shows—the source of which was probably below the lowest beds exposed in the district—were decisively unfavourable factors in the region along the coast.

"Further inland, in the basin of the Sepik—or Kaiserin Augusta—River, although no oil-shows were found throughout a great thickness of beds, geological conditions were more favourable, and this region was traversed by a general strike line which passed also through the Wakde district, in Dutch New Guinea, about 80 miles over the border, where oil was known to occur. The geologist therefore felt justified in submitting a plan for further geological survey of the Middle Sepik basin."

The report has been considered by the Federal Government, which favours the proposal to make additional surveys. In the meantime, the Government will maintain its policy of refusing to grant oil leases, or licences for prospecting for oil, in the mandated territory.

## PETROL PIER AT BOMBAY.

THE petrol pier at the northern end of Bombay Harbour has been brought into service. A petrol steamer was moored to it on May 12th and her cargo was successfully pumped along the pipe line to the tanks at Sewri. It is expected that a cheapening of petrol will result from the opening of the pier. The pier head is 410ft. in length, and will be extended during the next fair season to 570ft. in order to accommodate any oil vessels visiting the port. The approach channel will also be dredged further so as to allow vessels drawing 28ft. to reach the berth at any time in the year. The pier head is connected with the mainland by an open-work pier of reinforced concrete more than 2000ft. in length, and then by an embankment, 10ft. wide at the top and nearly 9000ft. long, running over mangrove and mud swamps and carrying a narrow-gauge line over which light motor trolleys run. Two pipes, one 8in. for petrol and the other 10in. for paraffin, run from the pier head to the oil company's depôts nearly five miles distant. It is hoped that tankers will be able to use the pier at practically all seasons of the year.

## AUTOMATIC SUB-STATIONS.

THE recently published report of the Committee appointed by the Board of Trade to investigate the water-power resources of the United Kingdom establishes an assumption that the water power of Great Britain will permit of the economical development of 210,000 kilowatts on a twenty-four-hour basis continually throughout the year. It is held accordingly that a considerable fraction of our demand for energy could be met by developing this asset. It is, however, doubtful, according to a writer in the Metropolitan-Vickers *Gazette*, whether industrial water power can be found in sufficient volume, except in isolated instances, to make its development by manually operated apparatus a commercial success, and it seems safe to assert that, if this large reservoir of power is to be utilised through the medium of a number of small stations each working on a low head, more attention than has hitherto been the case will have to be given to automatic generating and sub-station plant.

## Catalogues.

THE STAVELEY COAL AND IRON COMPANY, Limited, Chesterfield.—Monthly stock list of cast iron pipes.

THE ANDERSON-GRICE COMPANY, Limited, Carnoustie.—New illustrated pamphlet on "Stone-working Machinery."

JOHNSON AND PHILLIPS, Limited, Charlton, S.E. 7.—Booklet just published describing transformer oil-testing equipments.

VISLOK, Limited, St. Bride's House, Salisbury-s quare, Fleet street, E.C. 4.—Pamphlet dealing with the Vislok lock nut.

MUSGRAVE BROTHERS, Crown Point Foundry, Leeds.—New catalogue on hydraulic machine tools and oil mill machinery.

THE CASSELL CYANIDE COMPANY, Limited, Glasgow.—Small pamphlet, entitled "Case-hardening Heat Treatment of Steel by Cyanide."

ATELIERS DE CONSTRUCTIONS ELECTRIQUES DE CHARLEROI, 56, Victoria-street, S.W. 1.—A copy of this firm's monthly stock list for May, 1922.

BRITISH INSULATED AND HELSBY CABLES, Limited, Prescot, Lancs.—Pamphlet P 174 on cables for working pressures of 11,000 volts and over.

THE ASSOCIATED BRITISH MACHINE TOOL MAKERS, Limited, 17, Grosvenor-gardens, S.W. 1.—May–June issue of *British Machine Tool Engineering*.

CHRISTIANI AND NIELSEN, 74, Victoria-street, S.W. 1.—Catalogue of marine and harbour works which have been designed by them in reinforced concrete.

W. H. DORMAN AND CO., Limited, Stafford.—An illustrated catalogue on Dorman's "Flexstel." Many applications are shown in the catalogue and prices are given.

AUTOMOTIVE PRODUCTS COMPANY, 3, Berners-street, W. 1.—A leaflet, entitled "An End to Belting Troubles." The "Autoduct" link v. belting is described and illustrated.

BRUNTONS, Wire Mills, Musselburgh, Scotland.—Second edition of the brochure on the firm's research laboratory. Pictures are reproduced of many of the testing machines used for testing wire and wire ropes.

DICTOGRAPH TELEPHONES, Limited, Aurelia-road, Mitcham-road, Croydon, Surrey.—Pamphlet, entitled "Saving the Time which Costs Most." The advantages claimed for the dictograph in the office and works are explained.

CROSBY VALVE AND ENGINEERING COMPANY, Limited, 41–2, Foley-street, London, W. 1.—Pamphlet which contains an illustrated description of the "Wilson" blast recorder which measures and records both the volume and pressure of air fed into a cupola.

# Provincial Letters.

## THE MIDLANDS AND STAFFORDSHIRE.

*(From our own Correspondent.)*

### Steel Makers and the "Cut."

STEELMAKERS are strongly hoping that the effect of the reduction of 10s. per ton in the price of steel plates and sections to which I referred in the Latest News column last week will be to bring out a certain amount of business now in suspense, since it is hardly likely that another reduction will be declared for some time, and buyers, therefore, have no inducement to postpone business. This is the first change in price for some months, the last change being made in October. The drop is viewed with disfavour by some of the local producers as more likely to unsettle the market than to consolidate values on the new basis. One or two Midland makers intimate that their prices will remain as before. They refuse to lower their quotations on the ground that they have already accepted heavy losses to promote an improved state of trade all round, but no advantage has accrued to them. Unfortunately, in this district three rolling mills belonging to Alfred Hickman, Limited, Spring Vale Blast-furnaces, Bilston, have had to be put out of action owing to trade slackness and the further fall in steel values increasing the losses, which for some time past have been a matter of serious concern to steel makers. It is probable that what weighed with the Steel Makers' Association in coming to its decision to reduce prices was the difference of 5s. between the price at which Belgians were offering angles and the official basis in this country, together with the competition in plates converging from several directions. There was, moreover, the cutting of unassociated houses at home to be taken into account. It was felt that associated producers ought to be given greater latitude to meet competition, even though some of them were indisposed to seek further business at unremunerative rates. It is rather significant that the reduction has not, up to the time of writing, brought any quotations from Scotland, and although no announcement has yet been made to that effect, it is believed here that steel makers have decided to revert to the arrangement under which sales were restricted to certain areas. This should help the steel makers of the district, who have been subject to rather keen Northern competition, although constructional engineers by no means relish the limitation of their sources of steel supply. Some little foreign competition still exists in steel, but the prices are not now competitive, and the English makers expect to hold their own. Antwerp exporters have been quoting £9 15s. for angles, which is 5s. more than the new minimum here.

### Black Country Mills Closed Down.

The steel trade, especially as regards finished bars, has been so bad of late and prices have been so unremunerative that Alfred Hickman, Limited, Spring Vale, Bilston, have closed three of their bar mills for an indefinite period, and some 800 to 1000 men have been thrown idle. The stoppage coincides with the reduction in steel prices. The firm does not care to continue longer making at a loss, and it is understood the stoppage is also connected with the high railway rates, on which a great deal of dissatisfaction still exists. Mr. W. Hutchinson, jun., the managing director of the firm, says that owing to the heavy burden of railway rates, which are a terrible handicap to all Midland manufacturers, they were cut out of all export, and most of the long-distance inland, trade. This, combined with the effects of the engineering dispute, had forced his firm to shut down its finished bar department. The effect of the relief given by the railway companies had been practically negligible as far as the Midland steel manufacturers were concerned. "Until the railway charges are materially reduced trade will not revive," said Mr. Hutchinson, "and we shall not be able to reopen that particular section of our works." How serious the handicap of railway rates is for this district may be judged when one recollects that the action of Messrs. Hickman follows upon the important statements made by Mr. Cyril E. Lloyd, of Hingley and Sons, Limited, recorded by me last week, that the railway rates are driving Midland industries either to the coast or out of existence.

### Wire.

A fairly good business is being done just now in steel wire, and though the official price of wire rods is £11 10s., low-grade rods have changed hands at under £10 7s. 6d. Makers have been forced to accept this figure in order to secure orders which would otherwise have gone to Belgian houses, who are quoting £10 7s. 6d. for wire rods delivered Birmingham. Strenuous endeavours are being put forth by British producers to keep control of the overseas trade in bright steel wire where they have to meet determined foreign competition. The Staffordshire Steel Hoop Association's agreed price is still £12. Unassociated makers have been offering supplies at lower rates for some time past, however.

### Manufactured Iron Trade.

The resumption of work in the engineering industry has created a more optimistic tone among ironmasters here. Business is now expected to come along, and prices all round are well held. It cannot be said that the practical result of the settlement is yet in evidence. One reason is that this district has all along had a larger number of men at work than any other district, and there is, therefore, less leeway to make up. A brisker demand is anticipated in the near future for marked bars, orders having been held up for some weeks owing to the lock-out. The basis remains at £13 10s., at which it has stood since the beginning of April. Prices of nut and bolt grades of unmarked bars have been steadied by the improved demand. Makers would to-day require very favourable specifications to induce them to relax their quotation of £10. Orders have this week been declined at cut rates. Few sales of nut and bolt bars, in fact, are now made under £10 either for Staffordshire or Lancashire makes. Belgian prices are £1 or more below native quotations, but as long as buying is on hand-to-mouth lines foreign competition will not seriously worry local manufacturers who can send along the material in small quantities as required. Foreign offers are "without engagement," and deliveries are delayed. The trade in galvanised sheets is quiet, and on the whole rather disappointing. Makers are finding it difficult to maintain the £16 f.o.b. Liverpool basis. Some likely business with India has fallen through, owing to the unfavourable rates of exchange, the low value of the rupee making purchases from this country frequently impossible. An improved demand is, however, experienced from South America.

### Iron Gas Strip in Demand.

There is an improved demand for iron gas strip, and a fair number of orders for this material have this week been given out. It is hoped that some mills which have long been idle may be re-started shortly. For some time past makers of tubes have been using steel at considerably less cost than iron for the making of their products. But the values of iron have now fallen, and there are many users of tubes who prefer the older material on account of its greater resistance to corrosion. There is a good deal of foreign competition in the tube trade, especially with Canada, but the tube makers are meeting this by successive reductions quite successfully, and have no fear of their ability to hold their own in the world's markets. There is also some reversion to iron for the manufacture of sheets, owing to their greater durability, for roofing and other purposes where exposure to weather has to be taken into consideration.

### Expectant Pig Iron Market.

The pig iron market is in a state of expectancy. Current business is quiet, inquiry for export having diminished, but a broadening out of trade is expected as a result of the settlement of the labour trouble in the engineering industry. Stocks have been accumulating in makers' hands rather heavily lately, a state of things which, some time ago, threatened stoppage. Users, on the other hand, have not much iron available with which to carry on their foundries, and, it is believed, must soon come on the market for further supplies. Though the foundries have scarcely any stock, purchases of foundry pig have quickened hardly at all. The improvisation and interruptions of the past three months have necessarily deranged most departments of the engineering industry. Some time will elapse before this can be redressed. While there are considerable stocks of iron at the furnaces, a buying spurt would soon clear them out, but for a short time they must play an important part in the keeping down of prices and counteracting any improvement. Up to the present what improvement in demand there has been has not been strong enough to affect prices, and concessions can be obtained from most smelters for an attractive order. In one case it is reported an additional shilling was put on the price of pig iron. This circumstance was quite exceptional, but all round the greater firmness observed last week is maintained.

### Foundry Trades Exhibition.

It is claimed that the International Foundry Trades Exhibition, organised by the Birmingham Chamber of Commerce, in conjunction with the Institution of British Foundrymen, and the British Cast Iron Research Association, which has been held in Birmingham this week, is the most comprehensive and up-to-date display of the plant and equipment appertaining to the foundry industry ever held in England. There were in all about 120 exhibits, approximately 1000 tons of machinery had been installed, and between 300 and 400 horse-power was supplied to the working exhibits. While every phase of foundry plant was shown, the primary object of the exhibition was educational, and every effort was made to place before the foundry employer the scientific aspect of his work. An interesting feature has been the competitions for foundry employees for core making, moulding, and pattern making. These are the first of their kind to be held in this country, and it is hoped their educational effects will be marked. The exhibition has proved an unqualified success.

## LANCASHIRE.

*(From our own Correspondents.)*

MANCHESTER, Thursday.

### General Outlook.

THERE is a certain amount of improvement in the iron and metal markets this week, although business cannot yet be called active. The return of the engineers has coincided with, and perhaps has caused, a sharp demand for industrial coal in the Lancashire district, and collieries which did not know what to do with accumulations of slack have now managed to get clear, so that in the coal market one notices quite a scarcity of good slack, and a satisfactory demand for all kinds of industrial fuel. Of course, the scarcity of slack is caused not only by increased demand, but by the fact that there is no demand for house coal, and consequently very much less slack is produced; but nevertheless it is evident that industry is better, or at any rate that preparations, in the way of buying fuel, are being made for a better time. It is thought now that we are through the worst of the depression; but it would not do to suppose that the revival of trade is on any grand scale. It will yet take a long while to get back to normal prosperity; some say a couple of years, others five years; but in any case patience is still a very necessary virtue.

### Metals.

In the copper market there has been a set-back for a time, and one does not yet notice much revival in the demand from the engineering industry. It is probably too early to expect this, for the orders which will first come to hand from the trade will probably be for iron castings. Following this there should be a better demand for finished iron and steel, and finally for the non-ferrous metals; but it must be remembered that the industry has suffered severely, and that at present the main activity in it seems to be amongst the textile machinery makers. Probably one reason why the market for copper is still in a doubtful condition is that the American output has begun to increase rather rapidly. It is reported that copper producers in America are getting to work in many different places, and the question is whether consumption will grow fast enough to keep pace with them. The American Geological Survey statistics for 1921 have been published, and they show a fall in output, as between that year and the previous one, of over a quarter of a million tons, the figures for refined copper being 766,471 tons for 1920 and 502,900 tons for 1921. Whether the total output for this year will rival the output for 1920 is a doubtful question, but from now onwards a steady increase may be expected. With regard to the British prices for manufactured copper, it may be mentioned that there is a report from America to the effect that copper producers are contemplating new rolling mills. It is clear that these companies would have an enormous advantage over the British rolling mills if the latter continue to keep the difference between sheets and refined metal at £25 to £28 per ton. In the market for tin there has been a slight improvement, but it does not go very far, and as a matter of fact the fluctuations in the British tin market during the last three months may be covered by £5 per ton. Lead is still a very firm market, although the difference between prompt and forward metal is a little less than it was. Spelter has been slightly easier for a time, but no one expects any break in spelter prices.

### Pig Iron.

The markets for pig iron are perhaps a little better than they were, but there is no very definite change yet. Forge pig iron is still very much neglected, but there has been more buying of foundry pig in the Manchester district, and probably the demand here is now equal to the production of this class of iron at those furnaces which are near enough to pay the higher railway rate. Manchester used to draw a large proportion of her foundry iron from Lincolnshire, Northamptonshire and Cleveland; but in all these cases the increase in carriage has damaged this business. The rate from North Lincolnshire is not prohibitive, but these furnaces have not been started yet. Practically the Derbyshire furnaces are the only convenient source of supply and more of them will probably be lit up if the demand should continue to increase. It is possible that the prices here may keep firm and even increase a little, but no permanent rise is at all probable. This week sellers are usually asking about 92s. 6d. delivered in Manchester for No. 3 iron. Scotch iron is rather firmer; but the carriage on this is tremendous, and those who attempt to get it by water complain bitterly of the extravagant dock charges.

### Finished Material.

One does not notice yet any serious increase in the demand for finished iron and steel. Apart from the textile machinery section of the engineering industry there is not a great deal of activity yet in this district, and the buying of finished iron and steel by engineers has scarcely been begun. It is, however, hoped that a better inquiry will come on very soon. The recent reduction in sectional steel has had no effect.

### Scrap.

The market for scrap materials remains rather quiet. It is true that sellers of cast iron scrap report a better feeling, and some buying of this scrap is now going on. More work at the foundries will, of course, call for this class of scrap, and the prices here remain fairly steady at 82s. 6d. to 85s. for good broken machinery, and up to 90s. for "textile" scrap. The latter, of course, ought to be worth more than 90s. if common No. 3 iron is at 92s. 6d. Heavy wrought scrap is quiet at 60s. to 65s., and steel scrap is worth about 50s. at Lancashire stations. A few of the Lancashire works still pay only 60s. for wrought scrap; but most are now prepared to give 65s., and this is little enough from the dealers' point of view.

### Manchester Municipal Electricity Supply.

The annual report of the Electricity Committee to the City Council for the year ended March 31st last shows that the income from sales of current was £1,408,598, compared with £1,525,828 for the previous year. Other income amounted to £21,397, making a grand total of £1,429,995. The working expenditure, apart from depreciation, amounted to £977,102, compared with £1,115,239 for the previous year. From the balance of £452,893 had to be deducted £408,329 for interest, sinking fund, &c., leaving a net surplus of £44,564, which was transferred to the reserve fund. On capital account, the total outlay now reaches £5,607,698, the increase being mainly in respect of the Barton scheme. The mortgage debt stands at £3,248,936. The decrease in volume of business amounted to 21 per cent., the annual sales totalling approximately 158½ million kelvins. The average price paid for fuel—taking the stations as a whole—fell 1s. 4d. per ton during the past year. The average weight of fuel consumed rose .03 lb. per kelvin sold. The purchases of overseas coal during the coal strike made the average price much higher than it would otherwise have been. The efficiency of the distributing system as a whole equalled 84.77 per cent., the quantity absorbed in the mains and distributing stations being 15.23 per cent., an increase of 3.44 per cent. on the previous year. This increase was due to (*a*) the reduced sales in the year being on the large consumers' accounts where the efficiency of distribution is usually the highest, and (*b*) the March quarter meter readings being taken several days earlier than in the previous year.

### The Rating of Machinery.

One of the subjects which were dealt with at a conference of the Association of Assessment Committees in the North-Western District, held a few days ago at Southport, was that of the rating of machinery. Mr. Thomas White, Liverpool, who presided, said that in 1920 the principle of the Bill now before Parliament was approved

by the Association. The question now arose whether circumstances would justify a change in that attitude. He thought that a different case could now be made out for the relief of machinery from rating than had been made hitherto. His own Committee thought that the burden was not now being distributed as equitably in the matter of mills and factories as it was in the past. There was a serious danger of mills and factories being squeezed out of existence entirely by the burden of the rates. Now the duty of assessment committees was not solely that of agents to extract money, so that a question of this character could very properly engage their attention. Many industrial plants, he said, were operating an international and not a national trade, and the sooner they got working at their full capacity the sooner would the burden of unemployment relief be reduced. A resolution that the time was inopportune for passing the Bill was adopted by a majority of 22 to 11. Mr. R. Leach, Rochdale, who seconded the motion, said that the Bill before Parliament would not leave assessment committees with the liberties they now possessed. He agreed that industry should not be over-burdened, but it should be borne in mind that the Bill was not a Government measure, and that it had been promoted solely in the interests of machinery users.

### The Engineering Trades.

Matters in connection with the engineering industry are commencing to wear a more normal appearance this week. Although many firms have not yet been able to find employment for the whole of their former workers, I learn that in many sections the prospects are distinctly more cheerful since the resumption of business, due no doubt to an accumulation of work during the lock-out. The branches of the industry which appear to be most happily situated at the present time are the textile machine builders and the heavier branches of the electrical trade.

BARROW-IN-FURNESS, Thursday.

### Hematites.

It is too early to report any development in the hematite iron trade as a result of the end of the lock-out. Trade is about the same as yet, but it is certainly anticipated that there will be a steady improvement setting in shortly. Many of the engineers who will be requiring special qualities of iron have not got to work yet, and it will be some time before conditions again become normal. The output is not altered, but more iron is going into stock for two reasons, a falling off in the consumption on steel account locally, and interruption in orders from idle engineers. Before any more furnaces are put in blast the stocks to some extent will have to be disposed of. There is moderate but steady demand for manganese iron, and one furnace is regularly engaged on it. There have not been any shipments abroad during the last week; in fact, the only cargoes from Barrow have been pig iron for Connah's Quay, and ingot moulds for Llanelly.

### Steel.

The steel trade is dull, and there are but few orders about, for which there is considerable competition. Barrow works are but moderately employed, except in the hoop department, which continues to show the most activity.

### Iron Ore.

There is not much local ore being brought up, and such important mines as the Hodbarrow are still idle. Other mines are moderately employed, and the customers are mostly local. No Spanish ore arrived last week at all, but the run of the tides regulates the arrival of the heavy cargoes.

### Shipbuilding and Engineering.

There has been a steady stream of men returning to the works to secure employment, only to find very little for them. They have to sign, and are then informed that they will be sent for if wanted. A large proportion who left work will not be able to resume for some time, as orders are few at present.

## SHEFFIELD.

*(From our own Correspondent.)*

### Slow Recovery.

THOSE people who optimistically imagined that the settlement of the engineers' dispute would be immediately followed by feverish activity in the shops have been sadly disillusioned. A large number of the men themselves are among those who are learning that the dislocation of a great industry cannot be so quickly readjusted. A comparatively small proportion of the thousands who presented themselves at the works has so far been taken on, and each morning there are long queues of disappointed men turned away. The position will, of course, gradually right itself, but at the time of writing the number of unemployed registered is only a few hundred below the 48,000 to 50,000 level which has been maintained for many weeks past. It is not so much the lack of orders that is delaying the resumption of work on anything approaching a general scale, but it necessarily takes a week or so to get the shops into working order and jobs in hand sufficient to occupy any considerable number of men. A few more furnaces have been re-started, and their output is coming into the machine shops, and at a later stage there will be work for the fitters, but even at the time of writing—a week after the result of the ballot was known—the re-absorption of the men is still a slow process.

### Orders Lost and Gained.

There has been a certain amount of accumulation of orders during the stoppage, but, on the other hand, an even greater volume has been diverted to foreign competitors, and what improvement there is, as compared with the middle of March, when the stoppage occurred, is by no means general. Two of the most important branches of the steel industry which are badly off for work are those supplying railway and shipbuilding material, but this week there comes the comforting news that Cammell Laird and Co. have secured an order valued at £100,000 for steel wagons for the Indian railways. Although this order is primarily for the Nottingham branch of the establishment, the Sheffield and Penistone works should derive some benefit from the making of the tires and axles for the wagons. Bessemers have also received useful orders for tram tires from the London County Council and from the Sheffield Corporation. There is also a report that orders for the building of two or three big fruit-carrying vessels have been placed at Birkenhead, in the execution of which Sheffield will also benefit. It is expected that one at least of the new vessels will be electrically propelled, the generators being driven by oil engines and the propeller shaft motors being placed as far aft as possible with a view to providing the largest possible cargo space. The oil engines and generators may be on the main deck above the water line, thus constituting in effect a central power station. The engineering shops in Sheffield are the most favourably situated in the matter of orders, and work can soon be found for most of their men. Firms whose business is chiefly abroad report that prospects are brighter in a number of markets, colonial as well as foreign, but orders, while fairly numerous, are for the most part small in volume. The European market is still a very disappointing one, and likely to remain so until the exchanges are more favourable.

### More Steel Wanted.

Supplies of steel have been allowed to run very low, and until stocks have been replenished the machine and fitting shops will be handicapped. For more than a month Sheffield steel makers had been taking no hematite pig iron, but deliveries have now been resumed, and during the present week a number of steel furnaces have been re-started. In the not unlikely event of demand developing rapidly, the price of billets may advance; scrap is also scarce and likely to become dearer. The stagnation in special steels is still unrelieved, and ferro-alloys are finding few buyers. In this connection it is interesting to note that the Board of Trade returns for May are particularly favourable in tae iron and steel sections, the month being the best, as regards tonnage, since the slump set in. A striking feature is the buying of 17,000 tons of British pig iron by the United States, and large purchases by Belgium and Germany. Nearly all classes of steel show an increase, and though orders are comparatively small individually, they show a substantial increase in the aggregate.

### The Fuel Position.

The fuel position has not materially changed during the past week. There is a little better demand for industrial coal since the settlement of the engineers' dispute, but the market has not yet been appreciably affected, and collieries are still working short time. It is on this account, rather than because of any considerably increased demand that the position with regard to slacks is slightly more difficult, stocks having been reduced. Furnace and foundry coke is rather more in request, and prices are showing a hardening tendency. The sharp drop in the price of domestic coal announced on the London market early in the week had no parallel in this district, except to the extent of a shilling per ton in some of the cheaper grades, but industrial coal remains unaffected.

### Better News from the Districts.

Better news is to hand from the ironworks and engineering shops of Derbyshire and Lincolnshire. More furnaces are being started in the ironstone district of Lincolnshire, and the engineering industry of Lincoln will benefit as a result of an order received by Ruston and Hornsby, Limited, from the York Waterworks Company, details of which were given in your last issue. Lincoln, which has suffered very severely from the slump—something like one-sixth of its population having been reported to be in receipt of relief—will welcome this order, and in particular the firm of Ruston and Hornsby, which only a fortnight ago reported that last year's profits, amounting to £58,000, were £50,000 less than those for the previous year. From Derbyshire comes the encouraging report that, on an assurance of the co-operation of the men in increasing their output as the first essential, the directors of the Stanton Coal and Iron Company have promised to re-start their Alfreton ironworks, which have been closed for many months. There will also be more work at the Stanton furnaces. Two thousand men are affected by this interesting announcement.

### Mining Engineers in Sheffield.

Following last week's visit of the Iron and Steel Institute, Sheffield has this week welcomed the Institution of Mining Engineers on the occasion of its seventy-seventh general meeting. There has been a very satisfactory attendance, under the presidency of Sir John Cadman, who, in acknowledging a civic welcome on Tuesday, said the Institution fully realised its duty to the community, although its services were not always appreciated. He believed the coal industry had prepared itself to face the changes brought about by the war. Miners, owners and colliery managers had had a very lean year, but they were ready, when other industries were ready, to supply their demands. They recognised that cheap coal was essential to the industries of the country. The first session was devoted to the discussion of a paper by Dr. W. H. Hatfield, of the Brown-Firth Research Laboratory, Sheffield, on the application of stainless steel to colliery requirements. This paper was originally read before the Midland Institute of Mining, Civil and Mechanical Engineers, at Barnsley in April. Dr. Hatfield, who read a summary of the paper, contended that the mining industry did not take the best advantage it might of the great developments which had taken place in steel metallurgy during the last thirty or forty years. In the development of armaments, aircraft, automobiles, and other modern applications of steel there had been produced a series of very important steels having very much greater strength coupled with considerable and sufficient ductility, which he thought might be applied in different directions in connection with the mining industry. It seemed to him that there were many items which could usefully and economically be manufactured in stainless steel, such as boiler fittings, pump rods, pump cylinder liners, valve parts (whether for steam, water or air), impeller blades, rotary pumps, fan blades, pins for lifting apparatus, hooks, shackles, &c., while even wire ropes made of stainless steel, though costly, would be found to have a definite application under certain conditions. Experiments had been carried out in connection with rustless ropes, and he thought such ropes would be in use in certain collieries very shortly. Springs were being manufactured very successfully from rustless material. Rustless iron was another form of rustless steel; as a matter of fact, four types of rustless steel were now being produced. Another paper of interest was that by Mr. Eric Davies on "The Air-cooling Plant at the Morro Velho Mine, Brazil," which gave valuable evidence as to the influence of temperature on safe and profitable working. On Wednesday a paper on "Methods of Working the Barnsley Seam of the South Yorkshire Coalfield," was contributed by Lieut.-Colonel H. Rhodes, President of the Midland Institute, and Mr. M. Rhodes. This was followed by one on "Rock Temperatures in the Coal Measures," by Mr. J. Ivon Graham; and a third on "The Rate of Absorption of Poisonous Amounts of Carbon Monoxide by the Blood," by Mr. A. P. Veale, of the Mining Research Laboratory of Birmingham University. During the three days' visit the members were shown over a number of local works, and enjoyed some pleasant trips into the surrounding country, including visits to typical South Yorkshire collieries and new sinkings, and to the great new reservoirs and works in course of construction for the Sheffield Corporation Water Department.

### Corporation Schemes.

Sheffield City Council has accepted the tender of George Longden and Son, Limited, of Sheffield, for the construction of a new service reservoir in accordance with plans and specifications prepared by Mr. Kenneth P. Hawksley, the Council's consultant engineer, amounting (with the cost of cement and pipes to be supplied by the Corporation) to £37,417. Another new boulevard road is to be constructed, at an estimated cost of £80,000, as a means of providing work for the unemployed. On similar schemes the Council has already spent about £280,000, but some very great improvements have been carried out, and it is admitted that good value has been received for the money. The new road will enormously improve communication between Sheffield and Manchester, Huddersfield and other Lancashire and West Riding towns.

## NORTH OF ENGLAND.

*(From our own Correspondent.)*

### The Trade Outlook.

SIGNS are not wanting to encourage the hope that better times are in store for industry generally in the North of England. A movement, though somewhat on the slow side, towards recovery of trade is discernible, and perhaps a gradual rather than a sudden revival will be in the best interests of all concerned. Already improvement is reported in the iron and steel trade, and two more blast-furnaces have been put into operation in the Cleveland district. Preparations are also being made to put several others into blast in the near future. The fact is that synchronising with the improved prospects of business in the home market has come another spurt in the foreign trade. Inquiries from European countries are again more numerous, and moreover a large quantity of ordinary Cleveland foundry iron has been sold at current rates for immediate shipment to the United States, in addition to further sales of special iron for the same destination. It was feared that the refusal of local makers to cut prices would prevent any business being done except in special iron, but the Americans have now paid the price, and it is hoped that further business will accrue.

### Cleveland Iron Trade.

Much more interest is now being taken in the pig iron trade. Though many of the home foundries have scarcely started work, there is already an improvement in the demand, although the total volume of business is still somewhat restricted. Foreign buyers, however, are once more placing good orders in Cleveland. Competition is very keen. Belgian iron is again being offered in Scotland at prices below 96s. 8d. per ton, which is the f.o.t. price of No. 3 Cleveland G.M.B. at Grangemouth, whilst Lincolnshire iron is being offered f.o.t. Immingham at figures with which Cleveland cannot compete. Still, Cleveland is getting a fair share of the trade, though prices are firmly maintained, No. 1 and siliceous iron being quoted 95s.; No. 3 G.M.B., 90s.; No. 4 foundry, 87s. 6d.; No. 4 forge, 85s.; and mottled and white, 80s.

### Hematite Pig Iron.

The position of the East Coast hematite market is weaker owing to the anxiety to realise stocks. A steady trade is being done with Germany. There is a tendency to keep up the price to the home consumer and to cut to the foreigner, some of the makers quoting as high as 96s. per ton for mixed numbers for home consumption. On the other hand, business has been done at as low as 92s. 6d. for mixed numbers. The general quotation for mixed numbers, however, is about 94s., and for No. 1 95s.

### Iron-making Materials.

There is little or no movement in the foreign ore trade. The quotation of 27s. per ton for best Rubio ore is purely a sellers' figure, and to do business the price must be cut. Many, however, decline to do so, and consequently there is very little business in this class of ore. Supplies of Swedish ore are still coming into the Tees, and the hematite and basic ores of North Africa are also in better request. Fuel prices are distinctly easier, and good

Durham furnace qualities can now be bought at 26s. 6d. per ton delivered at the works.

**Manufactured Iron and Steel.**

The position in the manufactured iron and steel trade is much improved. A few orders have come forward, which should ensure somewhat more regular working at the mills now in operation. But it is impossible as yet to record any real recovery. The outlook is brighter and manufacturers are more hopeful, but business is still very slow, and the recent cuts have not brought in any greatly increased volume of business as yet. However, prices may now be regarded as stabilised for some time to come, and stabilisation is the first essential to trade recovery. Makers generally adhere to the fixed home prices, but there is keen cutting for foreign orders.

**The Coal Trade.**

The northern coal trade continues on a quiet and uneventful trend, with hardly anything of outstanding importance under consideration. The continental labour troubles made things very difficult for shippers on this side, but now they are practically settled there is expected to be a larger volume of business between this date and the end of August, when the present German import regulations come to an end. The inquiry from abroad is still only poor. France and Italy are apparently independent of British supplies and are not buying very extensively, while the call from the Scandinavian countries is remarkably restricted. The whole forward outlook is uncertain, as a result almost entirely of the fact that there is next to nothing being done in the way of contracts. Buyers in almost every instance, both for home and abroad, take the minimum quantities, either from week to week or month to month, presumably to enable them to take immediate advantage of any favourable movement in prices. All brands of best steams, both Northumberlands and Durhams, continue firm and at full prices, but it is chiefly a prompt trade that is being transacted. Small steams are firm and scarce. Gas coals are appreciably easier and are freely offered at slightly lower prices than recently. Coking coals are in slow demand and are freely pressed forward with poor results. The bunker market is also slack, with only a medium prompt demand. The coke market is moderately steady for foundries, but beehive coke is lower in price, while patent oven and all makes of gas coke are unchanged.

## SCOTLAND.

*(From our own Correspondent.)*

**Improving Conditions.**

TRADE conditions on the whole remain quiet and on recent lines, but certain markets are showing signs of more animation. Producers are making further efforts to meet consumers, and there seems a probability of their efforts bearing fruit soon. The settlement of the engineering dispute gives hope for the home markets, but the brightest feature at present is the better tone in the export departments. For some months back numerous and varied inquiries have come to hand, but few have materialised. The position is, however, changing, and a bigger percentage of the inquiries now bears fruit. The markets represented are chiefly colonial, but other countries are beginning to show more interest. The near approach of the annual holiday season may mean delay in opening up, but there are not lacking signs that manufacturers are disposed to get establishments in working order on something approaching the old scale. Steel prices are down a little, and other materials are likely to follow suit.

**Locomotive Orders.**

Further sign of improvement in the demand for railway material is found in the announcement of some recent orders placed with Scottish firms. The Caledonian Railway Company has arranged for the construction of twenty new engines by the North British Locomotive Company, Limited, and 500 mineral wagons by Hurst, Nelson and Co., Motherwell. Also, the North British Railway Company is to build several new engines in its own works. Further, it is reported that Hugh Symington and Sons, Limited, Glasgow, have an order to build a short railway in connection with a large colliery which is being opened up near Doncaster.

**Pig Iron.**

Business in pig iron tends to increase. Makers may not be enamoured of the prices obtained, but they are, nevertheless, arranging to augment output. The improvement is mostly in the export department as yet, but local consumers also are beginning to anticipate requirements. The extra furnaces to be put in blast will be engaged in the production of foundry qualities. The usual weekly meeting of the Glasgow pig iron "ring" again passed off without any transactions being done. There were sellers of Scotch No. 3 G.M.B. at 99s. f.a.s. Glasgow; No. 3 Cleveland G.M.B. at 90s. f.o.b. Middlesbrough; and mixed numbers East Coast hematite at 96s. f.o.b. Middlesbrough. Buyers were not quoted.

**Steel and Iron.**

It is yet early to expect any tangible result from the reduction in steel prices announced last week, but the immediate effect is a feeling of greater optimism in the market. Opinions differ as to the adequacy of these reductions, but in any case all are agreed that it is a step in the right direction. Orders for steel material are still very scarce, but with more activity apparent in the consuming trades it is only a matter of time until business must come along. In the shipyards, for instance, work has been resumed on several vessels. It is also hoped that the reductions in prices may enable shipbuilders to quote prices for new tonnage with a fair chance of success. Bar iron makers report a slight improvement in the export demand, but continued stagnation in the home market. Good progress is being made in the steel branches of this industry, principally, however, on export account. The steel sheet outlook is a little brighter, but there is still ample room for improvement.

**Firm Demand for Scrap.**

Scrap material is having a brisk run. Local consumers are a trifle more active, while the export demand is fully maintained. Good prices are mentioned, as much as 62s. 6d. to 65s. per ton being quoted. Heavy smelting scrap is the chief feature. Cast scrap is also in fair demand.

**Coal.**

The home market for coal remains in a disappointing condition. Round coal is poorly placed, and collieries are feeling very keenly the lack of business for these qualities. Many sidings are congested with loaded wagons, and employment is most uncertain. Industrial and household demands are exceptionally low. Prices are unsteady, and cheap terms are obtainable, but buyers are not taking advantage of this fact to anticipate requirements, being able often to secure small lots at almost their own figure. The stagnation in large coal has caused a scarcity in washed materials, and with these in firm demand for export prices continue to harden. During the past week a small vessel left Alloa for Aberdeen with a cargo of coal. This is the first shipment from Alloa since the war, but regular sailings are now expected. Aggregate shipments for the past week amounted to 296,433 tons against 286,748 tons in the preceding week and 358,045 tons in the same week in 1913.

**Unrest in Lanarkshire.**

If one believes all one hears, the cessation of hostilities in one industry will be succeeded by unrest in another. At least the colliery managers in Lanarkshire are somewhat apprehensive of the trend of affairs there. Dissatisfaction is expressed all over the county with the irregularity of employment, and the wages paid, and it is said that the possibilities of a strike are under discussion.

## WALES AND ADJOINING COUNTIES.

*(From our own Correspondent.)*

**Coal Trade Outlook.**

COMPARED with a week ago, it is to be doubted whether the outlook in the foreign coal export trade has displayed any change; certainly there has been no improvement, and for many grades of coal prices are a shade lower. Still, the fact remains that even the reduction of quotations does not bring any more business, and so the game goes on of the middlemen endeavouring to force the prices down still further in their effort to get orders from abroad. It is, however, a hard task, and complaints can be heard on all hands of the slackness of business and the gloomy prospects regarding the next month or two. For one thing, the foreign exchanges have gone against any expansion of operations. This is the root of all the depression in business. Buyers who had any intention of purchasing are in many cases postponing doing so in the hope that there will be some improvement in the exchange before long. Although coalowners are resisting to the utmost any concession in prices, they find it hard to turn down any offer of business which is definite, and especially if the purchaser can ship the coals immediately and so enable the colliery to get sufficient wagons to keep the pits going regularly. Many undertakings have not been able to avoid temporary stoppages, and this has had the effect of rather steadying the small coal market, particularly so far as the best qualities are concerned. The surprise to most people is that there has been so much chartering of tonnage of late, which shows that there is a fair amount of coal to be lifted; but unfortunately the quantity is not equal to production, and therefore no real life can be infused into the market until the demand from abroad increases to an appreciable extent. At the moment the inquiry is especially quiet from Italy and France, but in the case of Spain there is a little more activity, and the Norte Railways have asked for tenders for 30,000 tons of Admiralty list large or best Black Vein large for shipments to commence next month, the whole quantity to be delivered in fairly quick time. Of the 30,000 tons, 20,000 tons are to be shipped to the ports of Bilbao, Santander, Pasages and Corunna, and the balance to Barcelona, Tarragona and Valencia. The number of exporters to whom the business appeals is very limited, as it is generally considered that the railways' conditions are too stringent, and exporters do not like giving guarantees which may land them in substantial penalties. The Norwegian State Railways are also in the market for 15,000 tons of best Admiralty large double-screened for shipment during July, August and September, but here again the prospect of business materialising so far as coals from this district are concerned are not very bright, as the railways are in the market for North Country coals, and the probability is that the railways will draw upon the North for their requirements.

**Monopoly of South Wales Docks.**

THE notice of the Great Western Railway Company calling a special general meeting of the proprietors for the 28th inst. is interesting as it indicates the completion of arrangement of terms for the absorption of railways in the Western Group. The meeting is called to consider and, if thought fit, to approve a preliminary scheme for the absorption of eight railway companies. The result of the scheme will be to increase the capital of the Great Western Company from £115,000,000 to £153,000,000, while the company's single-line mileage will be increased to 7718, and the number of employees from 90,000 to 108,000. The purchase of the Burry Port undertaking will give the Great Western Company control of the docks there, and will complete the absorption of the whole of the docks of South Wales, with the exception of those of Swansea, for the acquisition of which a Bill will be promoted in the next session of Parliament.

**Coal Trimmers' Wages.**

The application now being made by the Shipping Federation for a further reduction of 25 per cent. in the wages of coal trimmers, will mean, if agreed to, a reduction of 50 per cent. on the base rates set out in the tariff scale arranged in August, 1920. It is doubtful, however, whether the actual earnings of the men will suffer to the extent indicated, as they are paid by results. Compared with the period from October, 1919, to September, 1921, the average rate of coal shipments from Cardiff, Penarth and Barry district was at the rate of 12,000,000 tons per annum, whereas in the first five months of this year coal has been shipped at an average rate of 19,000,000 tons per annum, which is an increase of 7,000,000 tons, so that while the base rates may be reduced by 50 per cent., it does not follow that the men's actual earnings will be affected to an equal extent.

**Trade in May.**

From all accounts the statistics regarding the coal export trade for the month of May are likely to turn out the most satisfactory for the whole of this year so far. The quantity shipped abroad was the best, and the prices were also good, with the result that although the net proceeds may not possibly be sufficiently high to pay the minimum wage in July without the owners surrendering some of their standard profits, there is a good chance that they will be high enough to enable the auditors to certify the payment of a much higher wage than that certified in any previous audits, and the owners may be able to retain the greater part of their standard profits. Unfortunately, there is no prospect of the minimum wage rate of the miners being improved upon, and it is also regrettable that since May the coal trade has fallen away both in volume of exports and in values.

**Non-unionist and other Trouble.**

The Eastern Valley of Monmouthshire has been the scene of a certain amount of trouble during the past week or two. It was never expected that the campaign against the non-unionist would pass off without a little disturbance. Last week about five thousand men struck work as a protest against the employment of non-members of the Federation, but as the majority of the latter fell into line the men resumed work before the end of the week. The workmen at the North Blaina and Lower Deep Collieries who came out on strike on Wednesday of last week on the same question are still idle, though efforts are being made to bring about a settlement. About 600 men at the Varteg Colliery received notices last Saturday terminating their contracts in a fortnight's time, but hopes are entertained that an arrangement will be come to whereby a fair percentage of the notices may be withdrawn. It is estimated that there are about 900 men in this district who have been idle since the national stoppage of last year. The Bargoed Colliery has given notices to a number of its workmen, and unfortunately it is understood that the district where these men work is to be closed.

**Current Business.**

The amount of actual business being done is very restricted, and for the few definite orders that are available there is very considerable competition. In many cases prices may nominally show no change, but salesmen will take less provided that the coal is for prompt shipment. Prices prevailing are certainly unremunerative so far as the collieries are concerned, and it is therefore considered that they cannot well fall any further as owners will rather stop working their properties than face further heavy losses. The strike of the American miners has not appreciably affected the market so far as steam coals are concerned, but anthracite coals are very firm, and one or two cargoes have been shipped to Canada, and with the prospect of more business coming their way, colliery owners will not quote for supplies ahead.

**Dock Charges.**

The general Committee representing coalowners, shipowners, &c., has arranged for an interview with Mr. Felix Pole, the general manager of the Great Western Company, for the 30th inst., with reference to an immediate further reduction in railway rates and dock charges. The patent fuel manufacturers of this district have also asked for an interview on the same subject.

**Swansea Metal Exchange.**

The tin-plate market is very steady, and makers are now well booked up to the end of July.

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RAILWAY companies are interested in the Harbours, Docks, and Piers (Temporary Increase of Charges) Bill, which was given a second reading in the House of Commons recently. In 1920 the Ministry of Transport was given power to allow increases in these charges, and this expires in February next. It is proposed by the Bill to extend the power for a further two years. Privately owned docks benefit equally with railway-owned.

THE sequel to the withdrawal of the North-Western-Midland Group Bill for powers for road transport is furnished by a special report of the Committee which was considering the Bill. This draws attention to the unnecessary expense caused to the promoters by the Ministry's delay in notifying its objection to the principle on which the charges were to be based. No criticism as to what was proposed on this head was mentioned in the Ministry's report of May 15th, and it was only disclosed on the tenth day of the proceedings by a witness who gave evidence at the request of the Committee. The report concluded: "The case for the petitioners was not fully before the Committee, but, subject to the possibility of eliminating unfair competition, the Committee are unanimously of opinion that it would be in the public interest to allow the fullest possible participation by the railway companies of this group and all competitors in the service of road transport."

# Current Prices for Metals and Fuels.

## IRON ORE

| | |
|---|---|
| N.W. COAST— | |
| Native | 25/- |
| (1) Spanish | 25/- |
| (1) N. African | 25/- |
| N.E. COAST— | |
| Native | — |
| Foreign (c.i.f.) | 27/- |

## PIG IRON.

| | Home. £ s. d. | Export. £ s. d. |
|---|---|---|
| (2) SCOTLAND— | | |
| Hematite | 5 8 9 | — |
| No. 1 Foundry | 5 0 6 | — |
| No. 3 ,, | 4 15 0 | — |
| N.E. COAST— | | |
| Hematite Mixed Nos. | 4 14 0 | 4 14 0 |
| No. 1 | 4 15 0 | 4 15 0 |
| Cleveland— | | |
| No. 1 | 4 15 0 | 4 15 0 |
| Silicious Iron | 4 15 0 | 4 15 0 |
| No. 3 G.M.B. | 4 10 0 | 4 10 0 |
| No. 4 Foundry | 4 7 6 | 4 7 6 |
| No. 4 Forge | 4 5 0 | 4 5 0 |
| Mottled | 4 0 0 | 4 0 0 |
| White | 4 0 0 | 4 0 0 |
| MIDLANDS. | | |
| (3) Staffs.— | | |
| All-mine (Cold Blast) | 13 0 0 | — |
| Part Mine Forge | *None offering.* | |
| North Staffs. No. 3 F'dry | 4 5 0 to 4 10 0 | |
| (3) Northampton— | | |
| Foundry Nos. 2 and 1 | *Nominal.* | |
| ,, No. 3 | 4 0 0 | — |
| ,, Forge | 3 10 0 to 3 12 6 | |
| (3) Derbyshire— | | |
| No. 3 Foundry | 4 2 6 to 4 5 0 | |
| Forge | 3 12 6 to 3 15 0 | |
| (3) Lincolnshire— | | |
| Basic | 4 0 0 to 4 5 0 | |
| Foundry | 4 5 0 to 4 10 0 | |
| Forge | 4 2 6 to 4 5 0 | |
| (4) N.W. COAST— | | |
| N. Lancs. and Cum. | | |
| Hematite Mixed Nos. | 5 15 0 | — |

## MANUFACTURED IRON

| | Home. £ s. d. | Export. £ s. d. |
|---|---|---|
| SCOTLAND— | | |
| Crown Bars | 11 0 0 | 10 15 0 |
| Best ,, | 12 0 0 | — |
| N.E. COAST— | | |
| Crown Bars | 12 0 0 | — |
| Tees | 14 10 0 | — |
| LANCS.— | | |
| Crown Bars | 11 10 0 | — |
| Second Quality Bars | 10 5 0 | — |
| Hoops | 14 0 0 | 13 15 0 |
| S. YORKS.— | | |
| Crown Bars | 12 0 0 | — |
| Best ,, | 13 0 0 | — |
| Hoops | 14 0 0 | — |
| MIDLANDS— | | |
| Crown Bars | 11 10 0 to 11 15 0 | |
| Marked Bars (Staffs.) | 13 10 0 | — |
| Nut and Bolt Bars | 10 0 0 to 10 5 0 | |
| Gas Tube Strip | 11 0 0 to 11 5 0 | |
| Hoops (*Nom.*) | 14 0 0 | — |

## STEEL.

| | (5) Home. £ s. d. | (7) Export. £ s. d. |
|---|---|---|
| (5) SCOTLAND— | | |
| Boiler Plates | 13 10 0 | — |
| Ship Plates ¾in. and up | 10 0 0 | — |
| Sections | 9 10 0 | — |
| Steel Sheets ¼in. to ⅜in. | 11 15 0 | — |
| Sheets (Gal. Cor. 24 B.G.) | — | 16 0 0 |

## STEEL (*continued*)

| N.E. COAST— | Home. £ s. d. | Export. £ s. d. |
|---|---|---|
| Ship Plates | 10 0 0 | — |
| Angles | 9 10 0 | — |
| Boiler Plates | 13 10 0 | — |
| Joists | 10 0 0 | — |
| Heavy Rails | 9 0 0 | — |
| Fish-plates | 14 10 0 | — |
| Channels | 14 10 0 | — |
| Hard Billets | 8 15 0 | — |
| Soft Billets | 7 15 0 | — |
| N.W. COAST— | | |
| BARROW— | | |
| Heavy Rails | 9 10 0 | — |
| Light ,, | 11 0 0 to 13 0 0 | |
| Billets | 9 5 0 | — |
| Ship Plates | 10 0 0 | — |
| Boiler ,, | 13 10 0 | — |
| MANCHESTER— | | |
| Bars (Round) | 9 10 0 to 11 10 0 | |
| ,, (others) | 10 10 0 to 11 10 0 | |
| Hoops (Best) | 15 5 0 | 15 0 0 |
| ,, (Soft Steel) | 12 5 0 | 12 0 0 |
| Plates | 9 10 0 to 11 0 0 | |
| ,, (Lancs. Boiler) | 15 10 0 | — |
| SHEFFIELD— | | |
| Siemens Acid Billets | 10 0 0 | — |
| Bessemer Billets | 12 10 0 | — |
| Hard Basic | 8 15 0 | — |
| Soft ,, | 7 15 0 | — |
| Hoops | 12 5 0 | — |
| Soft Wire Rods | 11 0 0 | — |
| MIDLANDS— | | |
| Small Rolled Bars | 9 5 0 to 9 10 0 | |
| Bessemer Billets | 7 10 0 to 7 12 6 | |
| Hoops | 11 10 0 to 12 0 0 | |
| Gas Tube Strip | 10 5 0 to 10 10 0 | |
| Sheets (24 W.G.) | 12 10 0 | — |
| Galv. Sheets (f.o.b. L'pool) | 16 0 0 | — |
| Angles | 9 10 0 | — |
| Joists | 10 0 0 | — |
| Tees | 10 10 0 | — |
| Bridge and Tank Plates | 10 0 0 | — |

## NON-FERROUS METALS.

| | |
|---|---|
| SWANSEA— | |
| Tin-plates, I.C., 20 by 14 | 19/6 to 19/9 |
| Block Tin (cash) | 152 7 6 |
| ,, (three months) | 153 7 6 |
| Copper (cash) | 62 2 6 |
| ,, (three months) | 62 10 0 |
| Spanish Lead (cash) | 24 10 0 |
| ,, (three months) | 23 12 6 |
| Spelter (cash) | 27 16 3 |
| ,, (three months) | 27 15 0 |
| MANCHESTER— | |
| Copper, Best Selected Ingots | 63 0 0 |
| ,, Electrolytic | 70 0 0 |
| ,, Strong Sheets | 94 0 0 |
| ,, Loco Tubes | 0 1 1½ |
| Brass Loco Tubes | 0 0 11½ |
| ,, Condenser | 0 1 2½ |
| Lead, English | 26 5 0 |
| ,, Foreign | 25 2 6 |

## FERRO ALLOYS,

(*All prices now nominal*).

| | Per Ton. | Per Unit |
|---|---|---|
| Tungsten Metal Powder | 1/8 per lb. | |
| Ferro Tungsten | 1/5 per lb. | |
| Ferro Chrome, 4 p.c. to 6 p.c. carbon | £27 | 10/- |
| ,, 6 p.c. to 8 p.c. ,, | £25 10 0 | 9/- |
| ,, 8 p.c. to 10 p.c. ,, | £24 10 0 | 8/- |
| ,, Specially Refined | | |
| Max. 2 p.c. carbon | £65 | 28/- |
| ,, 1 p.c. ,, | £30 | 30/- |
| ,, 0·75 p.c. carbon | £35 | 37/- |
| ,, carbon free | 1 1 per lb. | |
| Metallic Chromium | 5/3 per lb. | |
| Ferro Manganese (per ton) | £15 for home. | |
| ,, Silicon, 45 p.c. to 50 p.c. | £13 0 0 scale 5/- per unit | |
| ,, ,, 75 p.c. | £24 10 0 scale 6/- per unit | |
| ,, Vanadium | 18/- per lb. | |
| ,, Molybdenum | 5/6 per lb. | |
| ,, Titanium (carbon free) | 1/2 per lb. | |
| Nickel (per ton) | £180 | |
| Cobalt | 11/- per lb. | |
| Aluminium (per ton) | £110 to £120 (British Official). | |

## FUELS.

| SCOTLAND. | Export. |
|---|---|
| LANARKSHIRE— | |
| (f.o.b. Glasgow)—Steam | 18/6 |
| ,, ,, Nil | 18/6 |
| ,, ,, Splint | 20/- to 22/- |
| ,, ,, Trebles | 20/- |
| ,, ,, Doubles | 19/- |
| ,, ,, Singles | 18/- |
| AYRSHIRE— | |
| (f.o.b. Ports)—Steam | 18/6 |
| ,, ,, Splint | 20/- |
| ,, ,, Trebles | 20/- |
| FIFESHIRE— | |
| (f.o.b. Methil or Burntisland)—Steam | 18/- to 22/- |
| Screened Navigation | 26/- |
| Trebles | 20/- |
| Doubles | 19/- |
| Singles | 18/9 |
| LOTHIANS— | |
| (f.o.b. Leith)—Best Steam | 19/- |
| Secondary Steam | 18/3 |
| Trebles | 20/6 |
| Doubles | 19/- |
| Singles | 18/6 |
| ENGLAND. | |
| (8) N.W. COAST— | |
| Steams | 33/- |
| Household | 40/- to 61/8 |
| Coke | 34/- |
| NORTHUMBERLAND— | |
| Best Steams | 22/6 to 24/- |
| Second Steams | 20/6 to 21/6 |
| Steam Smalls | 13/- to 15/- |
| Unscreened | 20/6 |
| Household | 25/- to 28/- |
| DURHAM— | |
| Best Gas | 21/6 to 22/- |
| Second | 19/- to 21/- |
| Household | 25/- to 28/- |
| Foundry Coke | 32/6 to 35/- |
| SHEFFIELD— (Inland. | |
| S. Yorks. Best Steam Hards | 22/- to 23/- — |
| Derbyshire Hards | 20/- to 21/- — |
| Seconds | 18/- to 20/- — |
| Cobbles | 17/- to 19/- — |
| Nuts | 16/- to 18/- — |
| Washed Smalls | 10/- to 11/- — |
| Best Hard Slacks | 12/- to 13/- — |
| Seconds ,, | 9/- to 10/6 — |
| Soft Nutty ,, | 7/6 to 8/6 — |
| Pea ,, | 7/- to 8/- — |
| Small ,, | 2/- to 4/6 — |
| House, Branch | 36/- to 37/6 — |
| ,, Best Silkstone | 33/- to 34/- — |
| Blast Furnace Coke (Inland and Export) | 19/- to 21/- |

| (9) SOUTH WALES | |
|---|---|
| CARDIFF— | |
| Steam Coals: | |
| Best Smokeless Large | 26/- to 28/6 |
| Second ,, ,, | 25/6 to 26/- |
| Best Dry Large | 25/6 to 26/- |
| Ordinary Dry Large | 24/- to 25/- |
| Best Black Vein Large | 25/6 to 26/- |
| Western Valley ,, | 25/6 to 26/- |
| Best Eastern Valley Large | 25/- to 25/9 |
| Ordinary ,, ,, | 23/6 to 24/6 |
| Best Steam Smalls | 18/- to 18/6 |
| Ordinary ,, | 15/- to 17/- |
| Washed Nuts | 22/6 to 25/- |
| No. 3 Rhondda Large | 27/6 to 28/6 |
| ,, ,, Smalls | 20/- to 21/- |
| No. 2 ,, Large | 23/- to 24/- |
| ,, ,, Through | 19/- to 20/- |
| ,, ,, Smalls | 14/6 to 15/- |
| Coke (export) | 34/- to 35/- |
| Patent Fuel | 25/- to 27/6 |
| Pitwood (ex ship) | 29/- to 30/- |
| SWANSEA— | |
| Anthracite Coals: | |
| Best Large | 47/6 to 50/- |
| Seconds | 42/6 to 45/- |
| Red Vein | 30/- to 32/6 |
| Big Vein | 42/6 to 47/6 |
| Machine-made Cobbles | 57/6 to 60/- |
| Nuts | 55/- to 57/6 |
| Beans | 37/6 to 40/- |
| Peas | 24/- to 26/- |
| Breaker Duff | 8/- to 8/6 |
| Rubbly Culm | 15/6 to 16/- |
| Steam Coals: | |
| Large | 22/6 to 24/6 |
| Seconds | 20/- to 22/6 |
| Smalls | 14/- to 16/- |
| Cargo Through | 18/- to 20/- |

(1) Delivered. (2) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—F.O.B. Glasgow.

(8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

# French Engineering Notes.

*(From our Correspondent in Paris.)*

### Foreign Trade.

THE idea that the iron, steel and engineering trades would find ample employment with the carrying out of reconstruction work has failed of realisation, to the extent that the majority of firms are obliged to look to foreign markets for the disposal of their surplus production. The policy adopted of providing as much protection as possible to home industries was based upon the belief that the French demand would be sufficient for manufacturers, and at the same time it was expected that the fiscal tariffs would permit of Government securing special advantages under the commercial arrangements which it was proposed to carry out with different countries. Unfortunately, the reconstruction work is not being proceeded with so rapidly as had been anticipated on account of a lack of funds, and manufacturers are therefore finding the situation so precarious that they must look to foreign markets if they are not to run the risk in many cases of closing their shops altogether. The necessity of exporting has brought home to manufacturers the unfortunate effects of the fiscal policy, which has had no other result, for the time being, than to shut French goods out of foreign markets. In all branches of trade there is a growing impression that the policy of rendering the country self-supporting by developing home industries, and making it more and more difficult for foreign firms to do business in this country, is only possible when the country is able to provide those industries with plenty of work. Now that the iron, steel and engineering firms find that they must sell abroad they see that the present fiscal arrangements are disastrous, unless it be possible to utilise them as a lever for carrying out the scheme of separate commercial treaties. The refusal of foreign Governments to accept temporary treaties under conditions which do not provide them with sufficient advantages or an adequate guarantee has changed the whole situation. The friction created abroad by the constant putting up of import duties has obliged the Minister of Foreign Affairs to take a more direct interest in the treatment of economical questions with other countries. A Commission has therefore been formed in connection with the Commission for Foreign Affairs to investigate the various fiscal measures proposed and to control them to a certain extent, and it will have a voice in the negotiations for temporary treaties, from which it may be assumed that something will be done to adjust those treaties in a way to give satisfaction to other countries, instead of being carried out solely in the interests of particular industries, as was the case with the Spanish negotiations, when Spain replied to the exactions of certain French interests by shutting out French goods altogether. There is reason for believing that the work of the new Commission on Economic Questions will have the effect of eliminating present errors of policy, and giving a more practical character to the system of temporary treaties, which may at least prepare the way for a more liberal system of commercial exchanges in the future.

### Credits for Export.

Meanwhile, the situation of engineering firms is by no means satisfactory, although in some respects better than it is elsewhere; but it is becoming more and more clear that something drastic will have to be done to enable manufacturers to do business in foreign markets. The combinations carried out amongst certain interests for centralising effort in the Near East, in the Colonies and elsewhere, may in time give good results, but for the moment manufacturers are somewhat alarmed at their failure to secure foreign orders in competition with makers abroad. While the locomotive and wagon builders, for example, are very short of work, and have been cutting prices for export, they have been unable to secure any orders of importance. The conditions under which business can be done with certain countries are such that it is impossible to obtain large orders without a much stronger financial support than the majority of French firms are able to obtain. It is therefore proposed to create a vast organisation which will bring together all the most important financial bodies throughout the country, which will act in harmony with a similar organisation of the iron, steel and engineering trades. These latter will constitute a central association which will secure and distribute foreign contracts in much the same way as is being done for reconstruction work, and they will be backed by a financial group representing all the leading banks. A scheme on this basis has been prepared and submitted to the Minister of Commerce and Industry.

### Wages.

However manufacturers may organise themselves for the capture of foreign trade, they can do little unless they bring down productive costs. They are now striving to find a solution of this problem principally by a reduction in wages, which are out of all proportion to the amount of work done. The men are resisting these reductions in a way that gives a very precarious outlook to the industry. In the district of Lille, the operatives in the engineering trades have been on strike for more than a month, and there is no indication yet of the strike coming to an end. There can, however, be only one solution, for the locomotive builders and other firms have had to accept such low prices in competition with the Belgians that they must either reduce their costs or keep the works closed down. On the railways the Supreme Council has terminated its investigation into the working of the eight hours' day, which, it appears, is costing the railway companies one milliard francs a year. As the railways are under much the same legal obligations towards the men as the Government administrations, and are, consequently, unable to discharge them, the Council has suggested as the only way out of the difficulty that the men should be permitted, during a period of seven years, to work an additional 300 hours a year without remuneration. By this means the companies would realise an economy of 426 million francs a year. This would save the principle of the eight hours' day, which will probably be repealed by law if the men refuse.

# British Patent Specifications.

*When an invention is communicated from abroad the name and address of the communicator are printed in italics.*

*When an abridgment is not illustrated the Specification is without drawings.*

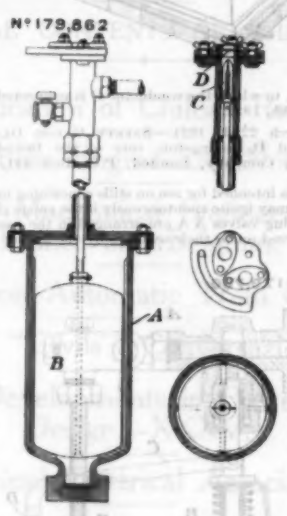
*Copies of Specifications may be obtained at the Patent Office Sale Branch, 28, Southampton-buildings, Chancery-lane, W.C., at 1s. each.*

*The date first given is the date of application; the second date at the end of the abridgment, is the date of the acceptance of the complete Specification.*

## STEAM ENGINES.

179,862. July 26th, 1921.—VACUUM BREAKERS, The Vulcan Boiler and General Insurance Company, Limited, and F. H. Bullock, 67, King-street, Manchester.

THIS invention relates to vacuum breakers used to prevent the cylinders of engines being flooded by water rising from the condenser. A chamber A is arranged in communication with the

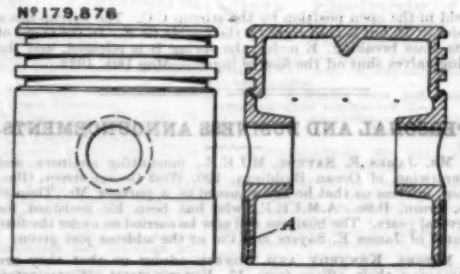



condenser and contains a float B. The stem of the float terminates in a knife C, which pierces a thin diaphragm D if the water rises to a dangerous level, and admits air, which thus destroys the vacuum.—*May 18th*, 1922.

## INTERNAL COMBUSTION ENGINES.

179,876. October 17th, 1921.—ALUMINIUM PISTONS, H. Baume, 79, Bicester-road, Aylesbury, and Cubitt's Engineering Company, Limited, Aylesbury.

In order to mitigate the "slap" which is caused by the large clearance required by aluminium pistons, the inventor surrounds the lower part of the piston skirt with a cast iron sleeve A, which

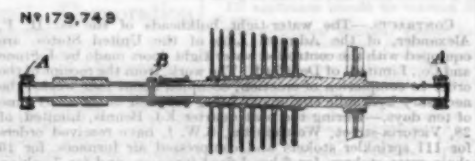



is shrunk in place. The sleeve is turned down to a diameter leaving only the clearance necessary for a cast iron piston, while the remainder of the piston is given the clearance required by aluminium.—*May 18th*, 1922.

## TURBINE MACHINERY.

179,749. March 17th, 1921.—GEARED TURBINE DRIVES, John Brown and Co., Limited, and S. J. Pigott, Clydebank, Dumbartonshire.

In order to provide a flexible connection between the turbine rotor and the pinion of the gearing, both the rotor shaft and the pinion are made hollow and a shaft is threaded right through

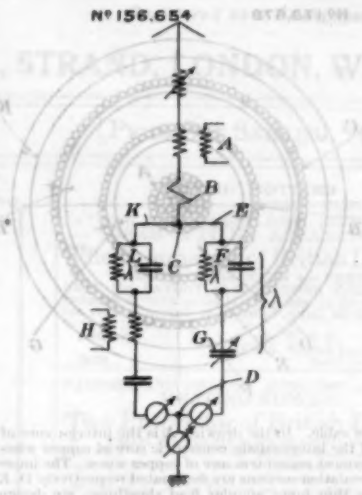



them. Flexible couplings A A are provided at the outer ends for connecting the inner shaft with the rotor and the pinion, while a plain coupling is arranged at B for assembly purposes.—*May 18th*, 1922.

## WIRELESS TELEPHONY.

156,654. January 6th, 1921.—IMPROVEMENTS IN WIRELESS ANTENNA SYSTEMS, Gesellschaft für Drahtlose Telegraphie m.B.H., of 9, Tempelhofer ufer Berlin.

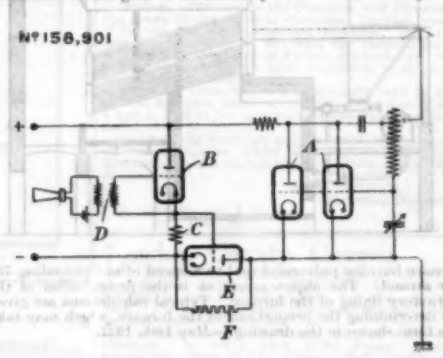
This invention relates to an antenna system which enables sending and receiving to be carried out simultaneously with different wave lengths on a single antenna. A is a transmitting circuit coupled with an antenna in which a microphone B is also connected. Below this microphone the antenna is branched at the point C, and the branches are again united at the point D. The branch E comprises a rejector circuit F, tuned to the waves to be received, and a condenser G, by which the whole of the branch E is tuned to the transmitted waves. At the points C and D the potential due to the transmitter is practically zero. The receiver H is coupled to the branch K, in which the rejector circuit L is tuned to the transmitted waves. Since the potentia




due to the transmitter is practically zero at the points C and D, the receiver is unaffected by the transmitter. Further, practically the whole of the received energy will pass through the branch K owing to the rejector circuit F in branch E.—*May 8th*, 1922.

158,901. February 9th, 1920.—IMPROVEMENTS IN WIRELESS TELEPHONE TRANSMITTERS, Gesellschaft für Drahtlose Telegraphie m.B.H., of 9, Tempelhofer ufer Berlin.

In parallel with the main valves A a valve B is connected in series with a resistance C across the high-tension leads. The grid filament circuit of the valve B includes the secondary of a transformer D, the primary of the transformer being connected to a microphone as shown. The filament of the valve B is also connected to the grid of an auxiliary valve E and through the

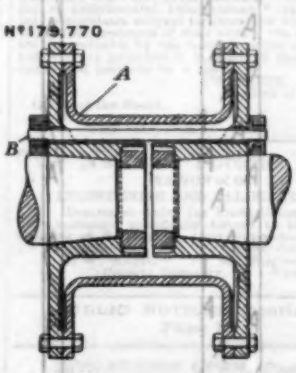



inductance C to the filament of the latter valve. F is an ohmic resistance in shunt with the auxiliary valve, and its function is to ensure the maintenance of the oscillatory condition of the generator valves A. With this arrangement many difficulties which have been found to occur in working with transmitters of the above type are obviated and greater efficiency is obtained.—*May 8th*, 1922.

## TRANSMISSION OF POWER.

179,770. March 24th, 1921.—FLEXIBLE COUPLINGS, K. Baumann, Northwood House, Barnfield, Urmston, Lancs., and the Metropolitan-Vickers Electrical Company, Limited, 4, Central-buildings, Westminster.

In this coupling flexibility is provided by means of the resilient



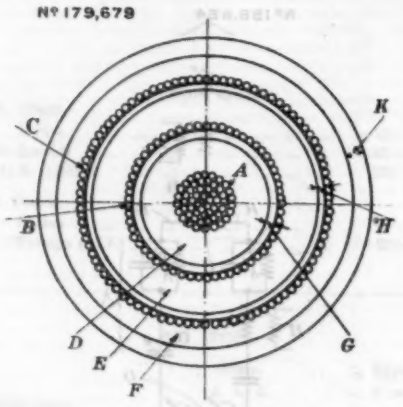

sleeve A, which also transmits the torque, while end thrust is taken care of by the single bolt B.—*May 18th*, 1922.

179,679. February 16th, 1921.—IMPROVEMENTS RELATING TO CONCENTRIC ELECTRIC CABLES, Alfred Mills Taylor, "Blade Lodge," Erdington, Birmingham.

The objects of this invention are to simplify the construction of extra high tension cables by avoiding the difficulty of impregnating such cables and to increase the reliability of such cables when transmitting power at very high voltages. The insulation which surrounds the innermost core is treated in the impregnation bath in the known manner before proceeding further with the manufacture of the cable, and directly afterwards the cable is covered in the usual way with a lead sheathing of considerably less thickness than usual, and in this condition it can be exposed to the air and again put into the stranding machine. A strand of copper wires can then be wound round the lead sheathing, and this forms the intermediate core of a three-core cable. This core is next insulated with paper in the same way as the preceding one, and it is then put into the impregnating bath. It

is then treated with a second thin lead sheathing, which in turn is surrounded by a strand of copper wires, which form the third or outermost core of the cable. This method of manufacture is continued until the insulation of the outer core is completed, when a thick protective lead sheathing is formed around the

No 179,679



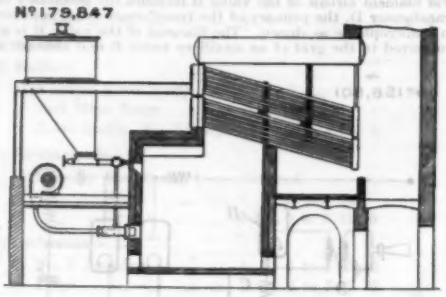

complete cable. In the drawing A is the interior core of copper wires, B the intermediate concentric core of copper wires, and C the outermost concentric core of copper wires. The impregnated paper insulation sections are designated respectively D, E and F. The two thin inner annular lead sheathings are designated G and H respectively, and the thicker outer lead sheathing is designated K.—*May 16th*, 1922.

## LIGHTING AND HEATING.

179,847. June 24th, 1921.—BURNING PULVERISED FUEL, *H. G. C. Fairweather*, 65-66, *Chancery-lane, London, W.C. 2.*

In this specification, which is a communication from the Fuller Engineering Company, of America, the chief claim appears to be for the limitation of the velocity of the gases through a

No 179,847



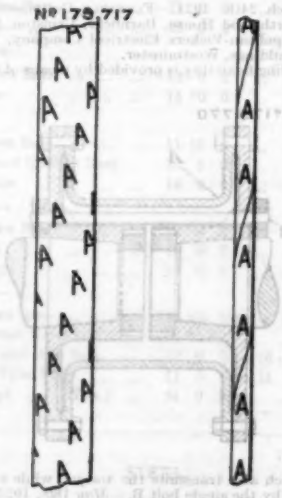
furnace burning pulverised coal to a speed of not exceeding 7ft. per second. The object aimed at is the preservation of the refractory lining of the furnace. Typical calculations are given for determining the proportions of the furnace, which may take the form shown in the drawing.—*May 18th*, 1922.

## MISCELLANEOUS.

179,717. February 25th, 1921.—IMPROVEMENTS IN OR RELATING TO TAPES FOR INSULATING THE CORES OF MULTI-CORE ELECTRIC CABLES, Henry Reginald Williams, of 241, Upper Brook-street, Manchester.

In order to identify the cores of multi-core cables it is usual to mark the insulating tapes with distinguishing marks or characters. If, however, the marks are printed in an upright position before the tapes are wound in the cores they appear at an angle when the tapes have been applied and the marks are

No 179,717

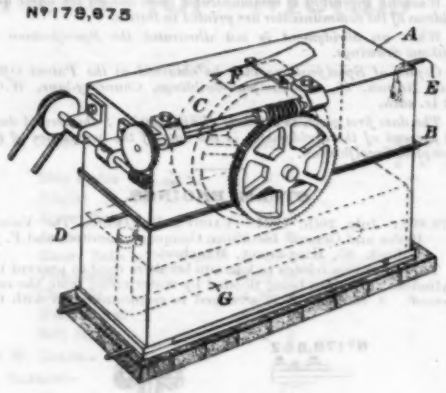


difficult to decipher, particularly when the cores are of small diameter. According to this invention the letters or other marks are printed on the tape at an angle as shown in the left-hand drawing, and when they are wound on the cores the marks become upright, as shown in the right-hand drawing.—*May 18th*, 1922.

179,675. February 14th, 1921.—IMPROVEMENTS IN AND RELATING TO ELECTROLYTIC METHODS OF DEPOSITING METALS AND APPARATUS THEREFOR, The British Thomson-Houston Company, of 83, Cannon-street, E.C. 4.

This invention relates to the production of electro-deposited iron. The container A is made in two sections, which may be separated at B, and the lower section contains the electrolyte. In the upper section there is a cylindrical cathode C, which may be composed of tungsten. The cathode is rotated by gearing in the manner shown. Current is supplied to the apparatus through the anode conductor D, and it leaves by way of the cathode conductor E. A strip of electro-deposited metal may be separated continuously from the arm C by a cleaning blade F.

No 179,675

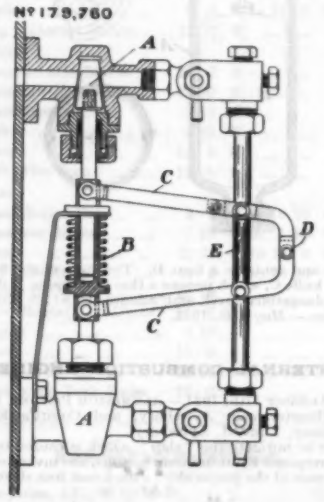



An iron anode, to which the conductor D is connected, is shown at G.—*May 15th*, 1922.

179,760. March 22nd, 1921.—SAFETY GAUGE GLASSES, W. Dallas and D. Livingston, care of the British Burmah Petroleum Company, Limited, P.O. Box 441, Rangoon, Burmah.

This device is intended for use on stills containing inflammable liquids, which may ignite spontaneously if the gauge glass should break. Two plug valves A A are arranged in the gauge fittings and can be forced on to their seatings by the spring B, but are

No 179,760




held in the open position by the stirrup C C. The stirrup has a joint at D, but is held rigid by the fusible tie E. In the event of the glass breaking, E melts, the spring B is released, and the plug valves shut off the flow of liquid.—*May 18th*, 1922.

## PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. JAMES E. SAYERS, M.I.E.E., consulting engineer and electrician, of Ocean Buildings, 190, West George-street, Glasgow, informs us that he has assumed as a partner Mr. Thomas G. Crum, B.Sc., A.M.I.E.E., who has been his assistant for several years. The business will now be carried on under the firm name of James E. Sayers and Co. at the address just given.

MESSRS. KENNEDY AND DONKIN advise us that they are removing their offices from 17, Victoria-street, Westminster, S.W. 1, to Broadway Court, 8, Broadway, Westminster, London, S.W. 1. The telegraphic address, "Kinematic, Vic, London," will remain unaltered, but the new telephone number will be Victoria 3601 (three lines). It is requested that on and after the 24th instant all communications should be sent to Broadway Court.

ALFRED HERBERT, Limited, of Coventry, informs us that since opening its South American branch office at 25, de Mayo, No. 267, Buenos Aires, it has been appointed selling agent for the following British manufacturers:—Vulcan Foundry, Limited, Newton-le-Willows; Clayton Wagons, Limited, Lincoln; British Griffin Chilled Iron and Steel Company, Limited, Barrow-in-Furness; Watson, Saville and Co., Limited, Sheffield; C. B. Parry, Limited, Liverpool; and Howell and Co., Limited, Wincobank.

CONTRACTS.—The water-tight bulkheads of the *ss. H. F. Alexander*, of the Admiral Line of the United States, are equipped with the controlled water-tight doors made by J. Stone and Co., Limited, of Deptford. The work, from the receipt of the order to completion of erection, occupied about four weeks, the necessary hydraulic equipment being supplied in the short time of ten days.—During the past quarter Ed. Bennis, Limited, of 28, Victoria-street, Westminster, S.W. 1, have received orders for 111 sprinkler stokers and compressed air furnaces, for 16 chain-grate stokers, for 6 hand-fired furnaces, and for 7 coking stokers and compressed air furnaces, the orders coming from forty separate customers.—The contract for the steel gates for the entrance of Palmers Dry Dock at Swansea, now in course of construction, has been placed with the engine works department of Sir W. G. Armstrong, Whitworth and Co., Limited. The contract includes, besides the gates themselves, the hydraulic gate-operating machinery, and the hydraulic capstans forming the equipment of the entrance.—Cammell Laird and Co., Limited, of Nottingham, have received orders for 400 all-steel covered goods wagons, 150 for the Great Indian Peninsula Railway and 250 for the Assam Bengal Railway.—The Paris–Orleans Railway has recently placed an important order for eighty electric locomotives with the Société Oerlikon and the Société de Construction des Batignolles, both in Paris. These locomotives, which are each for a one hour rating of 1720 horse-power, are specially intended for goods trains, and are to be capable of hauling a load up to 1200 tons. They are, however, also to be suitable for passenger service, in which case a speed of about 68 miles per hour must be attainable.

## Forthcoming Engagements.

*Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the* TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. 2. "Irrigation Enterprise in India," by Mr. F. W. Woods. 4.30 p.m.

TO-DAY AND SATURDAY, JUNE 24TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Annual general meeting and conference at Cardiff. For programme see page 670.

MONDAY, JUNE 26TH.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.—9, Conduit-street, Regent-street, W. 1. Presentation of the Royal Gold Medal. 8.30 p.m.

TUESDAY, JUNE 27TH.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, S.W. 1. Annual conversazione. 8.30 p.m.

THE SOCIETY OF ENGINEERS.—By permission of the Postmaster-General and the Engineer-in-Chief, a visit has been arranged to the Post Office Generating Station, Upper Ground-street, Blackfriars, the P.O. Railway Tunnel, and the Sorting Office, King Edward's Building. 2.30 p.m.

THURSDAY, JUNE 29TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—Natural History Museum, S.W. Annual conversazione. 8.30 to 11 p.m.

MONDAY, JULY 3RD.

THE ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly. General meeting. 5 p.m.

WEDNESDAY, JULY 5TH.

THE INSTITUTION OF LOCOMOTIVE ENGINEERS: MANCHESTER CENTRE.—Visit to the works of the Partington Steel and Iron Company, Limited, Irlam, near Manchester. The directors of the company have courteously invited members to luncheon prior to the visit. It is suggested members travel by the 12.33 p.m. train from Manchester Central (C.L.C.) to Irlam, in order to be at the offices at 1 p.m.

TUESDAY TO TUESDAY, JULY 4TH TO 11TH.

THE SOCIETY OF CHEMICAL INDUSTRY.—Glasgow. Annual general meeting.

WEDNESDAY TO FRIDAY, SEPTEMBER 20TH TO 22ND.

THE INSTITUTE OF METALS.—Swansea. Annual autumn meeting.

## LAUNCHES AND TRIAL TRIPS.

CHICAGO TRIBUNE; built by Swan, Hunter and Wigham Richardson, Limited, to the order of the Ontario Paper Company, Limited; dimensions, 250ft. by 43ft. by 19ft. 4in.; to carry wood pulp; engines, triple-expansion, pressure 180 lb.; constructed by North-Eastern Marine Engineering Company, Limited; launch, Tuesday, May 30th.

STEEL SCREW HOPPER BARGE, No. 18; built by Monmouth Shipbuilding Company, Limited, to the order of the Port of London Authority; dimensions, 215ft. by 35ft. 6in. by 19ft. 3in.; capacity for 1000 cubic yards of dredgings. Engines, one set triple-expansion surface-condensing, pressure 180 lb. per square inch; constructed by Fairfield's Shipbuilding and Engineering Company, Limited; launch, Saturday, June 10th.

MARIE LOUISE MACKAY, telegraph cable repairing steamer; built by Swan, Hunter and Wigham Richardson, Limited, to the order of Commercial Cable Company, of New York; dimensions, 246ft. by 34ft. by 24ft. 4in. Engines, twin-screw triple-expansion, supplied with steam by two boilers working under Howden's system forced draught and fitted to burn oil fuel; constructed by the builders; cable will be carried in three cable tanks, having a total coiling capacity of about 18,000 cubic feet; launch, Thursday, May 11th.

SAN FABIAN, oil tanker; built by Sir W. G. Armstrong, Whitworth and Co., Limited, to the order of Eagle Oil Transport Company, Limited; dimensions, 530ft. by 69ft. 4in. by 42ft. 3in.; to carry 18,000 tons deadweight. Engines, Parsons turbines; steam supplied by five boilers working at 220 lb. pressure, arranged for forced draught and oil fuel; constructed by the Walsend Slipway and Engineering Company, Limited; twelve main oil compartments, designed to carry full cargo benzine or cargo of three distinct classes of oil; fitted four pumps, each capable of discharging 300 tons of oil per hour; trial trip, recently.

SOCIETY OF CHEMICAL INDUSTRY.—The annual general meeting of the Society of Chemical Industry will be held on July 4th to July 11th inclusive, in Glasgow. The programme will be as follows:—Tuesday, July 4th: 10.45 a.m., annual general meeting, president's address in the Institution of Engineers and Shipbuilders; 1 p.m., luncheon in Grosvenor Restaurant; 3 p.m., garden party at The Knowe, Pollokshields; 7.30 p.m., reception and dance in the municipal buildings. Wednesday, July 5th: 10 a.m., Messel Memorial Lecture, by Professor H. E. Armstrong; 1 p.m., luncheon; 2.30 p.m., visits to Provan chemical works or Dalmarnock power station; 7.30 p.m., annual dinner in Grosvenor Restaurant. Thursday, July 6th: 10 a.m., Cinematograph Exhibition or visit to harbour; 1 p.m., luncheon; 2.30 p.m., session, Chemical Engineering Group, "Evaporation and Distillation:" (1) "Observations on the Design of Ammoniacal Liquor Stills," by Mr. P. Parrish; (2) "Tar Distillation," by Mr. W. A. Walmsley; 7 p.m., session, Chemical Engineering Group: (1) "The General Problem of Evaporation," by Professor J. W. Hinchley; (2) "Glycerine Distillation," by Mr. T. H. Gray. Friday, July 7th: Excursion on Loch Lomond, leave Glasgow about 10 a.m.; 8 p.m., conversazione in the Royal Technical College, by invitation of the Glasgow Section. Saturday, July 8th: Visit to Nobel's Explosives Company, Limited, Ardeer; luncheon by invitation of Nobel's Explosives Company, Limited; demonstration of explosives. Train will leave St. Enoch Station at 9.20 a.m. Monday, July 10th: Visit to the Trossachs. Train leaves Glasgow at 10.10 a.m. Tuesday, July 11th: Visit to Edinburgh and to places of historical interest in the neighbourhood; to the University; to the new chemical laboratories, and to the Forth Bridge.